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AIRBORNE LABORATORY MEASUREMENT OF AIRCRAFT PERFORMANCE  
AND STABILITY AND CONTROL FOR LIGHT AIRCRAFT SUPPLEMENT  
(U) AIR FORCE ACADEMY CO K R CRENshaw 24 JUN 83

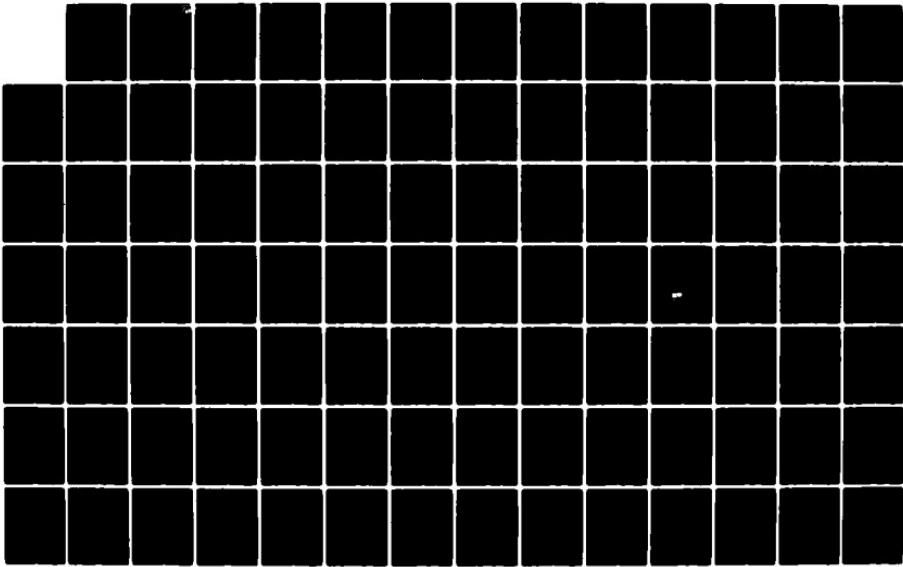
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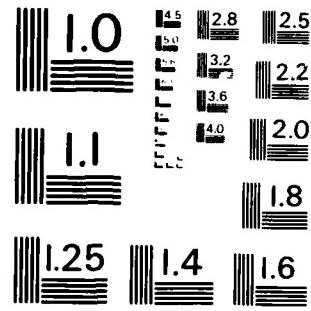
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MICROCOPY RESOLUTION TEST CHART  
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USAFA-TN-83-3



**Department of Aeronautics  
Dean of the Faculty  
United States Air Force Academy  
Colorado 80840**

**AIRBORNE LABORATORY MEASUREMENT  
OF AIRCRAFT PERFORMANCE AND STABILITY  
AND CONTROL FOR LIGHT AIRCRAFT**

**TECHNICAL NOTE  
USAFA-TN-83-3**

Crenshaw, K.R.

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This Technical Note is approved for publication.

*Thomas E. McCann*  
Thomas E. McCann, Lt Colonel, USAF  
Director of Research and Continuing Education

## FORWARD

Groundwork on the USAF Academy's Airborne Laboratory, a concept enthusiastically endorsed by Colonel Daniel H. Daley and Lt Colonel Richard C. Oliver, began during the Spring semester of 1982. With the final approval of the Dean of the Faculty and the Superintendent, a new Aero 495 course, "Flight Test Techniques," was taught for the first time during the Fall semester of 1982. Designing the course, planning flight profiles, and handling logistical and other administrative details were accomplished with the help of Captain William C. Roberson. Instrumentation support for measuring important in-flight parameters was provided by Captain Theodore J. Moody of the Department of Electrical Engineering and Mr. Thomas D. Fultz of the Department of Civil Engineering. With the continued support of those mentioned above and the prospective involvement of future members of the Department, the Airborne Laboratory has enormous potential. Aero 495 is expected to become a permanent course in the Aeronautics curriculum by the Fall semester of 1984. What follows is a technical description of the course as it exists today along with sample data and plots.

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AIRBORNE LABORATORY MEASUREMENTS OF AIRCRAFT PERFORMANCE  
AND STABILITY AND CONTROL FOR LIGHT AIRCRAFT

Kent R. Crenshaw\*

Abstract

This report is a supplement to the article "Integration of an Airborne Laboratory into the United States Air Force Academy Academic Curriculum" in USAFA-TR-83-2. It contains the test plans, flight test planning guides, and aircraft specifications handouts used during the applications phase of the Department of Aeronautics Airborne Laboratory. Sample calculations and plots from actual flight test data taken by cadets are also included. While the test plans, flight test planning guides, and aircraft specifications were designed to be used with the Beechcraft Sierra and Sundowner, the formats are sufficiently general so that they can be applied to any single-engine, general-aviation aircraft. Commonly recognized flight test techniques are used for gathering data, and data reduction is accomplished using accepted procedures.

I. Introduction

The Department of Aeronautics Airborne Laboratory is divided into two phases: "performance" and "flying qualities." Each student receives two flights during each phase, using the Beech Sierra to evaluate performance and the Beech Sundowner to evaluate flying qualities. The geometry, performance charts, and weight and balance data for each aircraft are shown in Appendix A.

II. Performance

The flying portion of the performance phase is conducted according to a test plan with a format similar to that used at the AFFTC (Air Force Flight Test Center). The test plan, shown in Appendix B, defines specific performance objectives that must

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be met if the advertised performance of the test aircraft is to be verified. It also serves as an administrative tool by dividing the students into two separate test teams and by addressing flying and ground safety considerations. Performance parameters that are evaluated include maximum speed, range and rate-of-climb capability, service ceiling, and glide ratio.

Both performance evaluation flights last approximately one hour with Flight 1 dedicated to gathering aircraft cruise and turn performance data and Flight 2 to gathering aircraft climb and descent data. A "Flight Test Planning Guide," shown in Appendix C, is provided to assist the students in their preparation for each flight. Mission events, pilot and student responsibilities, and post-flight data reduction requirements are clearly defined. In addition, data sheets, data reduction sheets, and an "Initial Flight Test Report" form modeled after AFFTC Form 365 are used. After each flight, the cadets submit for grading a flight report that satisfies the requirements laid out in the "Flight Test Planning Guide." See Appendix D for sample performance data records, data reduction, and plots.

### III. Flying Qualities

Like the performance phase of the Airborne Laboratory, the flying qualities phase is conducted according to a test plan. The test plan objectives (shown in Appendix E) are to evaluate the Beech Sundowner 180 C23, both qualitatively and quantitatively, as a primary trainer for Class I as defined in

MIL-F-8785C, "Flying Qualities of Piloted Airplanes." The aircraft is evaluated for compliance with selected paragraphs of this document. The test plan also serves the administrative purpose described in the performance section of this paper.

Both of the flights in the flying qualities phase last approximately one hour. Flight 3 is dedicated to evaluating longitudinal and lateral-directional stability and control as well as maneuvering flight. Flight 4 concerns dynamic stability and stalls. A "Flight Test Planning Guide," shown in Appendix F, outlines each flight in detail and helps the student to prepare for flying and to reduce post-flight data. See Appendix G for sample flying qualities data records, data reduction, and plots.

#### IV. Conclusions

While the test plans, flight test planning guides, and aircraft specifications handouts contained in this report were designed to be used with the Beechcraft Sierra and Sundowner, the formats are sufficiently general so that they can be applied to any single-engine, general-aviation aircraft. The test plan serves primarily as a statement of purpose and objectives, but it is also a useful administrative tool for organizing the flight test effort and addressing safety considerations. The flight test planning guide lays out the specific engineering requirements for each flight. While this might be interpreted as "leading the cadets by the hand," taking data in-flight is very different from gathering data in a ground-based laboratory

environment. The flight test planning guide gives the individual without experience in general aviation aircraft all the information he or she needs to fly an effective and efficient flight test mission. It eliminates guesswork about the specific test parameters needed in-flight and makes the flight experience both productive and rewarding.

### Symbols

#### English Symbols

|                      |  |
|----------------------|--|
| (A)                  | actual   |
| ALT                  | altitude   |
| BHP <sub>iw</sub>    | brake horsepower, instrument and weight corrected                  |
| BHP <sub>s</sub>     | standard brake horsepower from engine chart                        |
| BHP <sub>t</sub>     | test brake horsepower from engine chart                            |
| C <sub>D</sub>       | coefficient of drag  |
| C <sub>L</sub>       | coefficient of lift  |
| C <sub>P</sub>       | propeller pressure coefficient                                     |
| c.g. or CG           | center of gravity  |
| (dH/dt) <sub>d</sub> | rate of climb with density correction applied                      |
| (dH/dt) <sub>p</sub> | rate of climb corrected for engine power and propulsive efficiency |
| DEG                  | degrees  |

|                     |                             |
|---------------------|-----------------------------|
| $F_e$               | elevator stick force        |
| $F_R$               | rudder force                |
| $FF$                | fuel flow                   |
| F.M.                | flight manual               |
| FPM                 | feet per minute             |
| FPS                 | feet per second             |
| FT                  | feet                        |
| FWD                 | forward                     |
| $g$                 | acceleration of gravity     |
| " $g$ "             | load factor                 |
| GPH                 | gallons per hour            |
| GD                  | ground                      |
| $H_c$               | calibrated altitude         |
| $H_i$               | indicated altitude          |
| $h_m$               | stick-fixed maneuver point  |
| $h'_m$              | stick-free maneuver point   |
| $h_n$               | stick-fixed neutral point   |
| $h'_n$              | stick-free neutral point    |
| $H_{PI}$            | indicated pressure altitude |
| $H_s$ or $H_{std}$  | standard altitude           |
| $H_t$ or $H_{test}$ | test altitude               |
| HP                  | horsepower                  |
| HR                  | hour                        |
| IAS ( $V_I$ )       | indicated airspeed          |
| IN                  | inches                      |
| J                   | propeller advance ratio     |

|                            |                              |
|----------------------------|------------------------------|
| KIAS                       | knots, indicated airspeed    |
| KTS                        | knots                        |
| $L/D$ <sub>max</sub>       | maximum lift over drag ratio |
| MAC or $\bar{c}$           | mean aerodynamic chord       |
| MAP                        | manifold pressure            |
| MCP                        | maximum continuous power     |
| MIN                        | minutes                      |
| MPH                        | miles per hour               |
| $n_t$ or $n_{test}$        | test load factor             |
| NAM                        | nautical air miles           |
| OAT                        | outside air temperature      |
| O/S                        | overshoots                   |
| (P)                        | predicted from flight manual |
| p                          | pressure at altitude         |
| $p_0$                      | sea level pressure           |
| PRESS                      | pressure                     |
| q                          | dynamic pressure             |
| $R_t$ or $R_{test}$        | test turn radius             |
| $R/C_s$ or $(dH/dt)_{std}$ | standard rate of climb       |
| $R/C_t$ or $(dH/dt)_t$     | test rate of climb           |
| RPM                        | revolutions per minute       |
| R/S                        | rate of sink                 |
| S                          | planform area of wing        |
| SAR                        | specific air range           |
| SE                         | specific endurance           |
| SEC                        | seconds                      |

|                                     |   |
|-------------------------------------|---|
| T                                   | period of oscillatory dynamic response    |
| t <sub>2</sub>                      | time to double amplitude                  |
| t <sub>1/2</sub>                    | time to 1/2 amplitude                     |
| T <sub>a</sub>                      | absolute outside air temperature          |
| T <sub>i</sub>                      | indicated outside air temperature         |
| T <sub>s</sub>                      | standard temperature at altitude          |
| T <sub>t</sub>                      | test temperature at altitude              |
| TACH                                | tachometer                                |
| TED                                 | trailing edge down                        |
| TEMP                                | temperature                               |
| TEU                                 | trailing edge up                          |
| VCAS (V <sub>c</sub> )              | calibrated airspeed                       |
| V <sub>e</sub>                      | equivalent airspeed                       |
| V <sub>iw</sub>                     | velocity, instrument and weight corrected |
| V <sub>t</sub>                      | test indicated airspeed                   |
| V <sub>true</sub>                   | true airspeed                             |
| VVI                                 | vertical velocity indicator               |
| W <sub>f</sub>                      | fuel flow in pounds (lb) per hour (hr)    |
| W <sub>s</sub> or W <sub>std</sub>  | aircraft standard weight                  |
| W <sub>t</sub> or W <sub>test</sub> | aircraft test weight                      |

#### Greek Symbols

$\omega_t$  or  $\omega_{test}$  test turn rate

|            |                                  |
|------------|----------------------------------|
| $\eta$     | propeller efficiency             |
| $\delta$   | pressure ratio $p/p_0$           |
| $\alpha$   | density ratio $\rho/\rho_0$      |
| $\rho$     | density at altitude              |
| $\rho_0$   | sea level density                |
| $\phi$     | bank angle                       |
| $\delta_e$ | elevator stick deflection        |
| $\delta_R$ | rudder deflection                |
| $\delta_a$ | aileron control wheel deflection |
| $\beta$    | sideslip angle                   |
| $\omega_a$ | actual frequency                 |
| $\omega_n$ | undamped natural frequency       |
| $\xi$      | damping ratio                    |

#### References

1. Crenshaw, Kent R., "Integration of an Airborne Laboratory into the United States Air Force Academy Academic Curriculum," Aeronautics Digest, USAFA-TR-83-2, USAF Academy, March 1983.

## **APPENDIX A**

**Specifications and Weight and  
Balance for the Beechcraft  
Sierra 200 C24R  
and  
Sundowner 180 C23**

SPECIFICATIONS  
AND  
WEIGHT AND BALANCE  
FOR THE BEECHCRAFT SIERRA 200 C24R

AERO 495

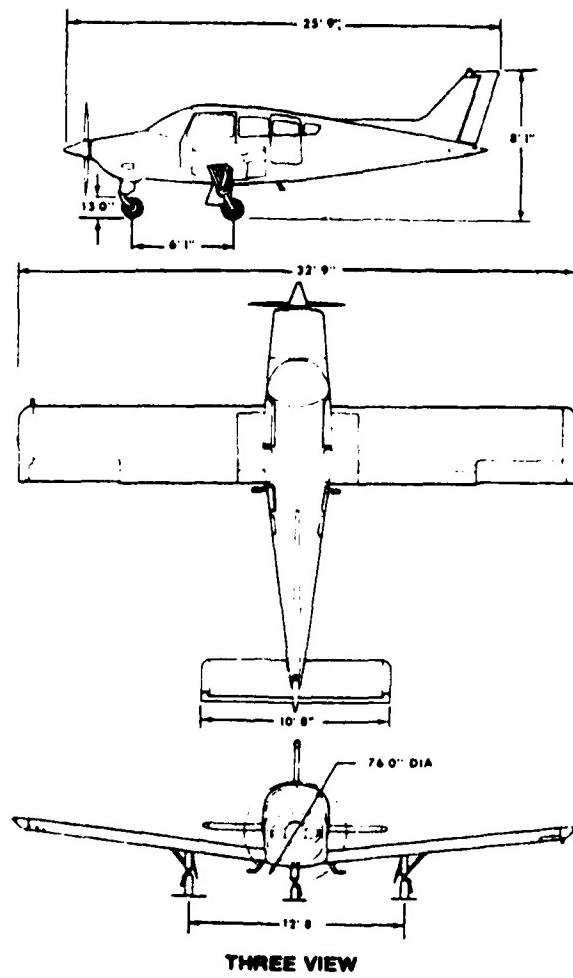
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|      | <u>CONTENTS</u>              |             |
|------|------------------------------|-------------|
|      |                              | <u>PAGE</u> |
| I.   | Geometry . . . . .           | 1           |
| II.  | General . . . . .            | 2           |
| III. | Performance Charts . . . . . | 3           |
| IV.  | Weight and Balance . . . . . | 18          |

## I. GEOMETRY

### A. Three View

BEECHCRAFT  
Sierra C24R



THREE VIEW

### B. Wing

|                             |                     |
|-----------------------------|---------------------|
| Span, b                     | 32' 9"              |
| Mean Aerodynamic Chord, MAC | 52.7"               |
| Area, S                     | 146 ft <sup>2</sup> |
| Aspect Ratio, R             | 7.5                 |
| Taper Ratio                 | 1.0                 |
| Dihedral                    | 6.0°                |

I. GENERAL

A. Engine - Avco Lycoming, 4 cylinder  
IO-360-A1  
Maximum continuous power (at sea level)  
200 HP @ 2,700 rpm  
Manifold Pressure Operating Range (15" to 28.7" Hg)

B. Propeller - Two-blade, Hartzell, constant speed  
Aluminum alloy  
Diameter 76"  
Restricted Operation - 2,100 to 2,350 rpm

C. Capacities

|                      |                     |
|----------------------|---------------------|
| Passengers and Pilot | 6                   |
| Oil                  | 8 quarts            |
| Fuel                 | 59.8 gallons        |
|                      | 57.2 gallons usable |

D. Design Load Factor

2,750 pounds, flaps up      +3.8 to -1.9

E. Airspeeds

|   |                 |
|---|-----------------|
| Takeoff (flaps 15°)                           | 66 KTS/76 MPH   |
| Climb (best rate, $V_y$ )                     | 85 KTS/98 MPH   |
| Climb (best angle, $V_x$ )                    | 71 KTS/82 MPH   |
| Maximum Glide                                 | 91 KTS/105 MPH  |
| Emergency Approach                            | 74 KTS/85 MPH   |
| Normal Approach (flaps down)                  | 70 KTS/81 MPH   |
| Cruise Climb                                  | 96 KTS/110 MPH  |
| Maximum Permissible Speed, $V_{NE}$           | 168 KTS/193 MPH |
| Maximum Landing Gear Extended Speed           | 135 KTS/155 MPH |
| Maximum Flap Extension Speed                  | 96 KTS/110 MPH  |
| Maneuver Speed                                | 125 KTS/144 MPH |
| IG Stall Speed (gear and flaps up, 2,600 lbs) | 65 KTS/75 MPH   |

**Section V**  
Performance

**BEECHCRAFT**  
Sierra C24R

**Section V**  
Performance

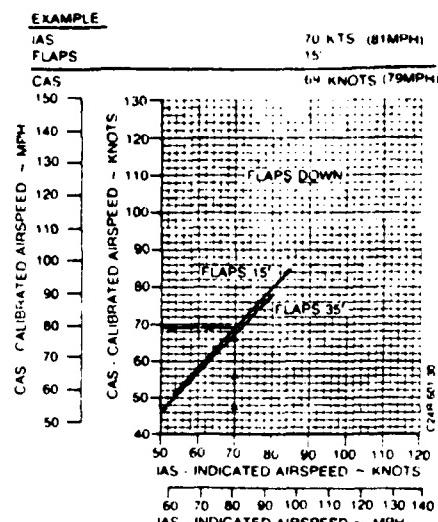
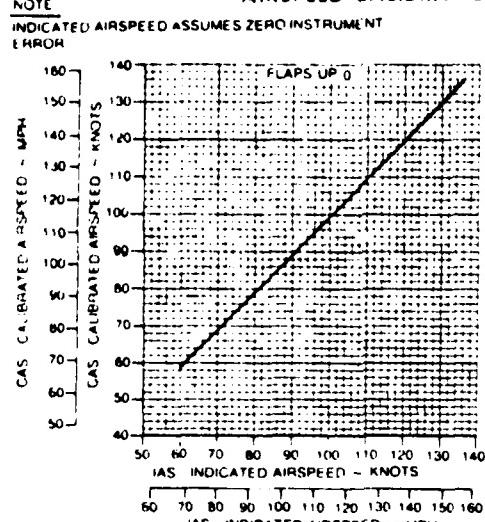
**BEECHCRAFT**  
Sierra C24R

**III. PERFORMANCE CHARTS**

**A. Pitot-Static Calibration Data**

5-10

**AIRSPEED CALIBRATION - NORMAL SYSTEM**

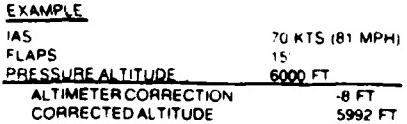
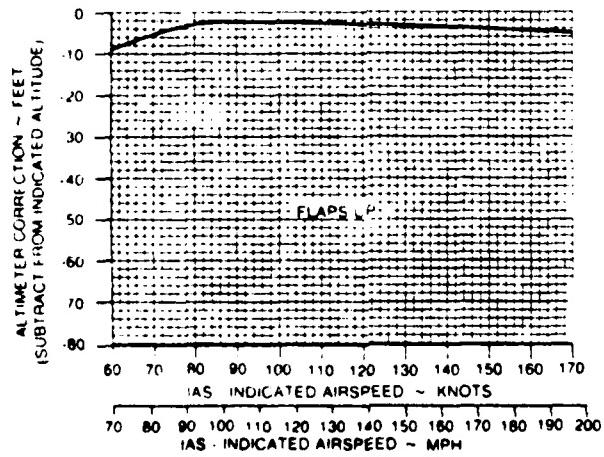


November, 1980

5-12

**ALTIMETER CORRECTION-NORMAL SYSTEM**

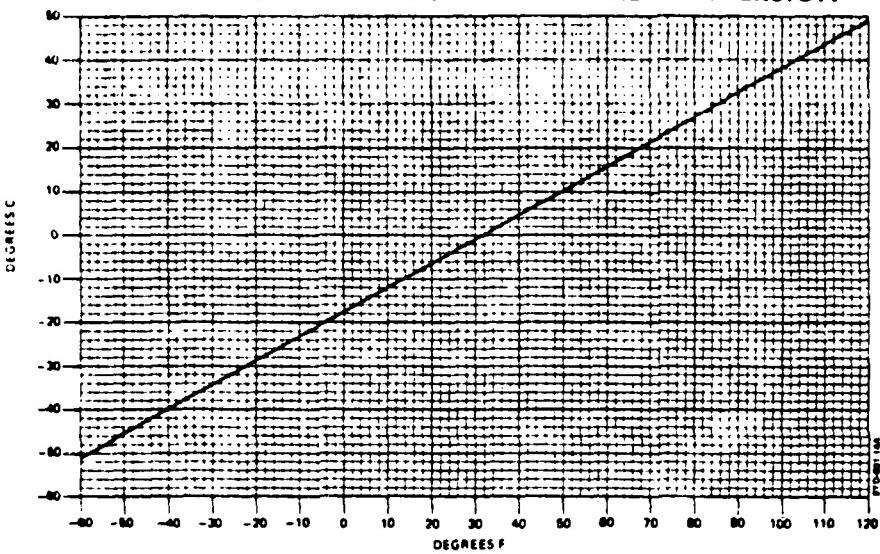
**NOTE**  
INDICATED AIRSPEED ASSUMES ZERO INSTRUMENT  
ERROR



November, 1980

B. Atmospheric Data

FAHRENHEIT TO CELSIUS TEMPERATURE CONVERSION

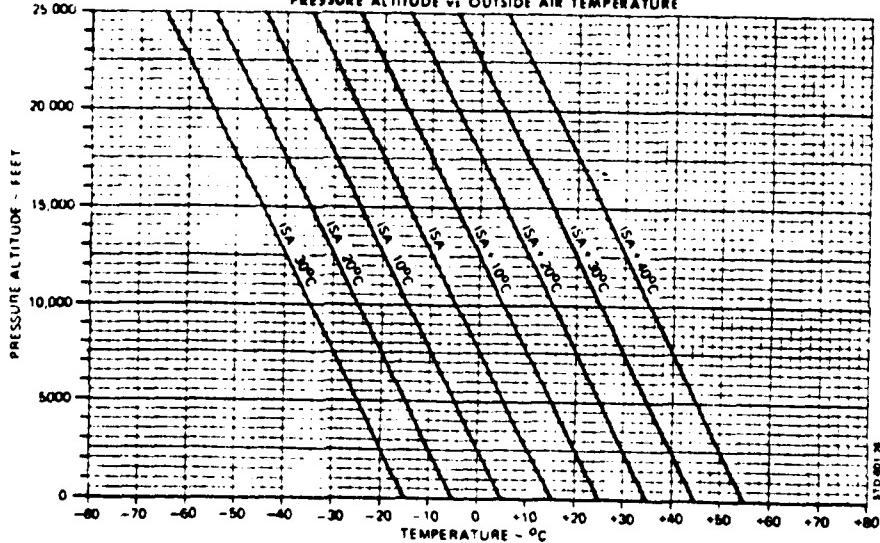


5-14

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ISA CONVERSION

PRESSURE ALTITUDE vs OUTSIDE AIR TEMPERATURE



November, 1980

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**Section V**  
**Performance**

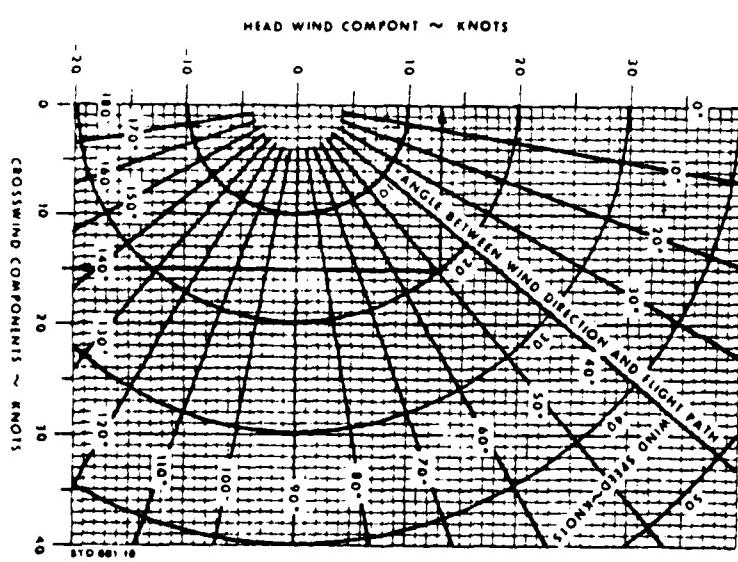
**BEECHCRAFT**  
Sierra C24R

**BEECHCRAFT**  
Sierra C24R

**Section V**  
**Performance**

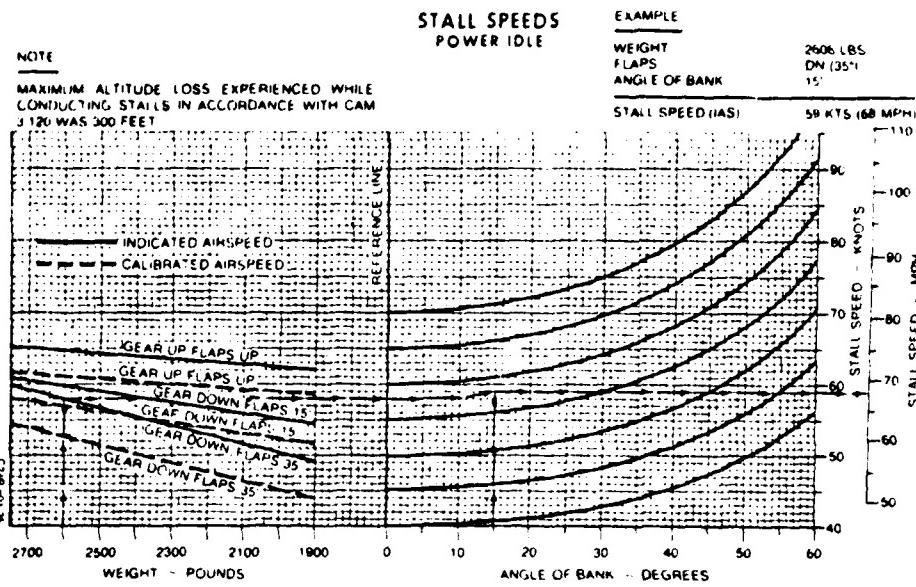
**WIND COMPONENTS**  
Demonstrated Crosswind Component is 17 kts

**EXAMPLE**  
WIND SPEED 70 KTS  
ANGLE BETWEEN WIND DIRECTION AND FLIGHT PATH 50°  
HEADWIND COMPONENT 13 KTS  
CROSSWIND COMPONENT 15 KTS



A-8

**C. Stall Speeds and Crosswinds**



5-16

November, 1980

November, 1980

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**Section V**  
**Performance**

**BEECHCRAFT**  
**Sierra C24R**

**BEECHCRAFT**  
**Sierra C24R**

**Section V**  
**Performance**

**D. Takeoff and Landing Data**

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S-33

**TAKE-OFF DISTANCE - HARD SURFACE**

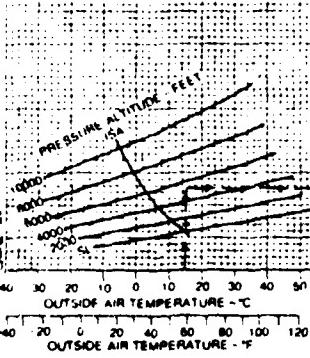
INITIAL SPEED IN KNOTS (78 MPH)

NET SPEED 78 KNOTS (82 MPH)

**ASSOCIATED CONDITIONS**

POWER TAKE OFF POWER SET BEFORE BRAKE RELEASE  
FLAPS UP  
GEAR RETRACT AFTER LIFT OFF  
Mixture LEAN TO APPROPRIATE ALTITUDE  
RUNWAY PAVED LEVEL DRY SURFACE

NOTE: CLIMB PERFORMANCE AFTER LIFT OFF IS LESS THAN 150 FT/MIN IF TAKE-OFF WEIGHT IS IN SHADDED AREA

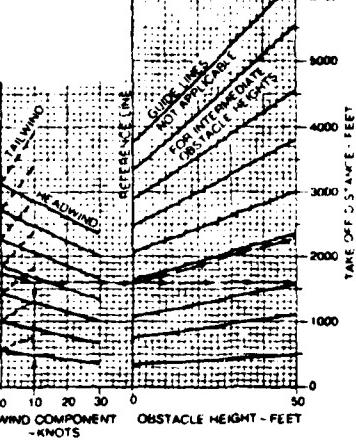


**EXAMPLE**

DATA  
PRESSURE ALTITUDE  
TAKE-OFF WEIGHT  
HEADWIND COMPONENT

15°C (59°F)  
5850 FT  
2750 LBS  
4 KTS

GROUND ROLL  
TOTAL DISTANCE OVER HORIZONTAL



**LANDING DISTANCE-HARD SURFACE**

**ASSOCIATED CONDITIONS**

POWER RETARD TO MAINTAIN  
800 FT/MIN ON FINAL APPROACH  
FLAPS DOWN (35°)  
RUNWAY PAVED HARD DRY SURFACE  
APPROACH SPEED AS TABULATED  
BRAKING MAXIMUM

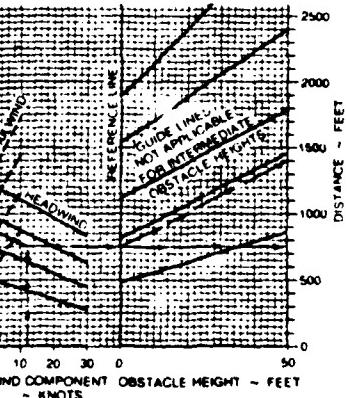
| WEIGHT<br>POUNDS | APPROACH<br>SPEED |     |
|------------------|-------------------|-----|
|                  | KNOTS             | MPH |
| 2750             | 70                | 81  |
| 2500             | 66                | 75  |
| 2300             | 62                | 71  |
| 2100             | 58                | 67  |

**EXAMPLE**

DATA  
PRESSURE ALTITUDE  
LANDING WEIGHT  
HEADWIND COMPONENT

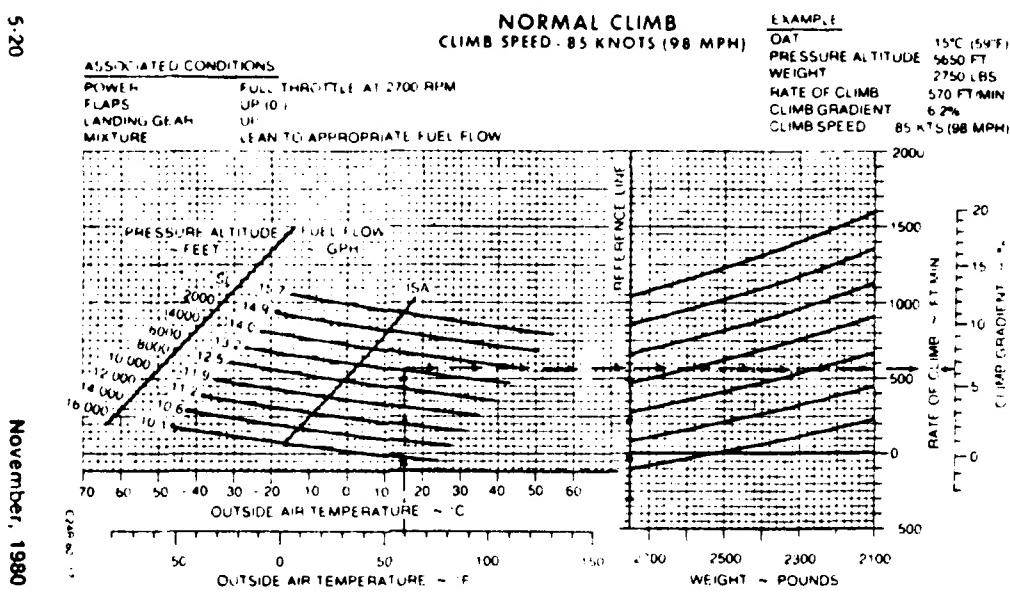
25°C (77°F)  
3025 FT  
2006 LBS  
12 KTS

GROUND ROLL  
TOTAL OVER 50 FT OBSTACLE  
APPROACH SPEED

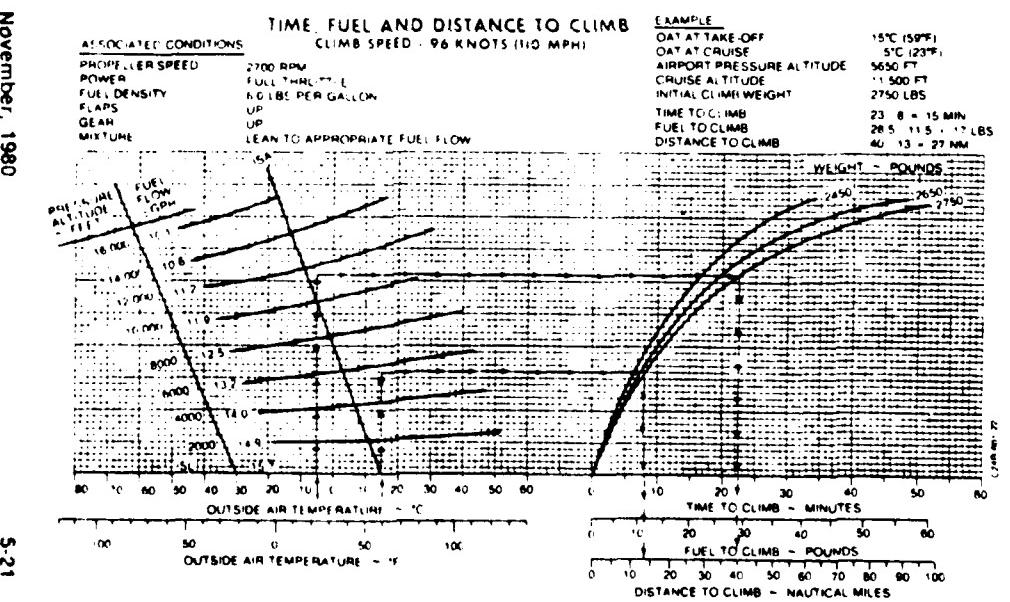


**Section V**  
**Performance**

**BEECHCRAFT**  
Sierra C24R



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**BEECHCRAFT**  
Sierra C24R

**Section V**  
**Performance**

F. Cruise Data

CRUISE POWER SETTINGS - 2700 RPM  
75% MCP (or FULL THROTTLE) - 2600 POUNDS

5-22

Section V  
Performance

BEECHCRAFT  
Sierra C24R

| PRESS ALT. | ISA -36°F (-20°C) |            |           |     |      | STANDARD DAY (ISA) |           |     |     |            | ISA +36°F (+20°C) |      |     |            |           |     |       |     |      |     |     |
|------------|-------------------|------------|-----------|-----|------|--------------------|-----------|-----|-----|------------|-------------------|------|-----|------------|-----------|-----|-------|-----|------|-----|-----|
|            | OAT               | MAN. PRESS | FUEL FLOW | TAS | OAT  | MAN. PRESS         | FUEL FLOW | TAS | OAT | MAN. PRESS | FUEL FLOW         | TAS  | OAT | MAN. PRESS | FUEL FLOW | TAS |       |     |      |     |     |
| FEET       | °F                | °C         | IN HG     | PPM | GPH  | KTS                | MPH       | °F  | °C  | IN HG      | PPM               | GPH  | KTS | MPH        | °F        | °C  | IN HG | PPM | GPH  | KTS | MPH |
| SL         | 25                | 4          | 22.4      | 61  | 10.2 | 123                | 142       | 61  | 16  | 23.0       | 61                | 10.2 | 125 | 144        | 99        | 37  | 23.6  | 61  | 10.2 | 128 | 147 |
| 1000       | 21                | -6         | 22.1      | 61  | 10.2 | 124                | 143       | 57  | 14  | 22.7       | 61                | 10.2 | 126 | 145        | 95        | 35  | 23.3  | 61  | 10.2 | 129 | 148 |
| 2000       | 18                | -8         | 21.6      | 61  | 10.2 | 125                | 144       | 55  | 13  | 22.4       | 61                | 10.2 | 128 | 147        | 91        | 33  | 23.0  | 61  | 10.2 | 130 | 150 |
| 3000       | 14                | -10        | 21.6      | 61  | 10.2 | 126                | 145       | 52  | 11  | 22.2       | 61                | 10.2 | 129 | 148        | 88        | 31  | 22.8  | 61  | 10.2 | 131 | 151 |
| 4000       | 12                | -11        | 21.3      | 61  | 10.2 | 127                | 146       | 48  | 9   | 22.0       | 61                | 10.2 | 130 | 150        | 84        | 29  | 22.5  | 61  | 10.2 | 133 | 153 |
| 5000       | 9                 | -13        | 21.1      | 61  | 10.2 | 128                | 147       | 45  | 7   | 21.7       | 61                | 10.2 | 131 | 151        | 81        | 27  | 22.3  | 61  | 10.2 | 134 | 154 |
| 6000       | 5                 | -15        | 20.9      | 61  | 10.2 | 129                | 148       | 41  | 5   | 21.5       | 61                | 10.2 | 132 | 152        | 77        | 25  | 22.1  | 61  | 10.2 | 135 | 155 |
| 7000       | 1                 | -17        | 20.7      | 61  | 10.2 | 131                | 151       | 37  | 3   | 21.3       | 61                | 10.2 | 133 | 153        | 73        | 23  | 21.9  | 61  | 10.2 | 136 | 157 |
| 8000       | 2                 | -19        | 20.5      | 61  | 10.2 | 132                | 152       | 34  | 1   | 21.1       | 61                | 10.2 | 135 | 155        | 70        | 21  | 21.8  | 61  | 10.2 | 137 | 158 |
| 9000       | 4                 | -21        | 20.3      | 61  | 10.2 | 133                | 153       | 30  | -1  | 20.9       | 61                | 10.2 | 136 | 157        | 66        | 19  | 21.5  | 60  | 10.2 | 137 | 158 |
| 10000      | -9                | -23        | 20.2      | 61  | 10.2 | 134                | 154       | 27  | -3  | 20.7       | 61                | 10.2 | 137 | 158        | 63        | 17  | 20.7  | 59  | 9.8  | 137 | 158 |
| 11000      | -13               | -25        | 20.0      | 60  | 10.2 | 134                | 154       | 23  | -5  | 20.0       | 59                | 9.8  | 136 | 157        | 59        | 15  | 20.0  | 57  | 9.5  | 136 | 157 |
| 12000      | -17               | -27        | 19.2      | 59  | 9.8  | 134                | 154       | 19  | -7  | 19.2       | 58                | 9.7  | 134 | 154        | 55        | 13  | 19.2  | 56  | 9.3  | 134 | 154 |
| 13000      | -20               | -29        | 18.5      | 58  | 9.7  | 133                | 153       | 16  | -9  | 18.5       | 56                | 9.3  | 133 | 153        | 52        | 11  | 18.5  | 54  | 9.0  | 132 | 152 |
| 14000      | -24               | -31        | 17.9      | 56  | 9.3  | 131                | 151       | 12  | -11 | 17.9       | 54                | 9.0  | 131 | 151        | 48        | 9   | 17.9  | 53  | 8.8  | 130 | 150 |

NOTES 1 Shaded area represents operation with full throttle  
2 Full throttle manifold settings are approximate

November, 1980

BEECHCRAFT  
Sierra C24R

Section V  
Performance

CRUISE POWER SETTINGS - 2500 RPM  
75% MCP (or FULL THROTTLE) - 2600 POUNDS

November, 1980

| PRESS ALT. | ISA -36°F (-20°C) |            |           |     |      | STANDARD DAY (ISA) |           |     |     |            | ISA +36°F (+20°C) |      |     |            |           |     |       |     |      |     |     |
|------------|-------------------|------------|-----------|-----|------|--------------------|-----------|-----|-----|------------|-------------------|------|-----|------------|-----------|-----|-------|-----|------|-----|-----|
|            | OAT               | MAN. PRESS | FUEL FLOW | TAS | OAT  | MAN. PRESS         | FUEL FLOW | TAS | OAT | MAN. PRESS | FUEL FLOW         | TAS  | OAT | MAN. PRESS | FUEL FLOW | TAS |       |     |      |     |     |
| FEET       | °F                | °C         | IN HG     | PPM | GPH  | KTS                | MPH       | °F  | °C  | IN HG      | PPM               | GPH  | KTS | MPH        | °F        | °C  | IN HG | PPM | GPH  | KTS | MPH |
| SL         | 25                | 4          | 23.6      | 61  | 10.2 | 123                | 142       | 61  | 16  | 24.4       | 61                | 10.2 | 126 | 145        | 99        | 37  | 25.1  | 61  | 10.2 | 129 | 148 |
| 1000       | 21                | -6         | 23.5      | 61  | 10.2 | 124                | 143       | 59  | 15  | 24.1       | 61                | 10.2 | 127 | 146        | 95        | 35  | 24.8  | 61  | 10.2 | 130 | 150 |
| 2000       | 18                | -8         | 23.3      | 61  | 10.2 | 125                | 144       | 55  | 13  | 23.9       | 61                | 10.2 | 128 | 147        | 91        | 33  | 24.5  | 61  | 10.2 | 131 | 151 |
| 3000       | 16                | -9         | 23.0      | 61  | 10.2 | 127                | 146       | 52  | 11  | 23.6       | 61                | 10.2 | 129 | 148        | 83        | 31  | 24.2  | 61  | 10.2 | 132 | 152 |
| 4000       | 12                | -11        | 22.7      | 61  | 10.2 | 128                | 147       | 48  | 9   | 23.4       | 61                | 10.2 | 130 | 150        | 84        | 29  | 24.0  | 61  | 10.2 | 133 | 153 |
| 5000       | 9                 | -13        | 22.5      | 61  | 10.2 | 129                | 148       | 45  | 7   | 23.1       | 61                | 10.2 | 131 | 151        | 81        | 27  | 23.7  | 61  | 10.2 | 134 | 154 |
| 6000       | 5                 | -15        | 22.3      | 61  | 10.2 | 130                | 150       | 41  | 5   | 22.9       | 61                | 10.2 | 132 | 152        | 77        | 25  | 23.5  | 61  | 10.2 | 135 | 155 |
| 7000       | 1                 | -17        | 22.1      | 61  | 10.2 | 131                | 151       | 37  | 3   | 22.7       | 61                | 10.2 | 134 | 154        | 73        | 23  | 23.2  | 60  | 10.0 | 135 | 155 |
| 8000       | 2                 | -19        | 21.8      | 61  | 10.2 | 132                | 152       | 34  | 1   | 22.4       | 60                | 10.0 | 134 | 154        | 70        | 21  | 22.4  | 59  | 9.8  | 134 | 154 |
| 9000       | -6                | -21        | 21.6      | 60  | 10.0 | 132                | 152       | 30  | -1  | 21.6       | 59                | 9.8  | 133 | 153        | 66        | 19  | 21.6  | 57  | 9.5  | 133 | 153 |
| 10000      | -9                | -23        | 20.8      | 59  | 9.8  | 131                | 151       | 27  | -3  | 20.8       | 57                | 9.5  | 132 | 152        | 63        | 17  | 20.8  | 56  | 9.3  | 131 | 151 |
| 11000      | -13               | -25        | 20.1      | 57  | 9.5  | 130                | 150       | 23  | -5  | 20.1       | 56                | 9.3  | 130 | 150        | 59        | 15  | 20.1  | 54  | 9.0  | 130 | 150 |
| 12000      | -17               | -27        | 19.3      | 55  | 9.2  | 129                | 148       | 19  | -7  | 19.3       | 54                | 9.0  | 128 | 147        | 55        | 13  | 19.3  | 53  | 8.8  | 127 | 146 |
| 13000      | -20               | -29        | 18.6      | 54  | 9.0  | 127                | 146       | 16  | -9  | 18.6       | 53                | 8.8  | 127 | 146        | 52        | 11  | 18.6  | 51  | 8.5  | 125 | 144 |
| 14000      | -24               | -31        | 17.9      | 53  | 8.8  | 126                | 145       | 12  | -11 | 17.9       | 52                | 8.7  | 125 | 144        | 46        | 9   | 17.9  | 50  | 8.3  | 123 | 142 |

NOTES 1 Shaded area represents operation with full throttle  
2 Full throttle manifold settings are approximate

November, 1980

**CRUISE POWER SETTINGS - 2400 RPM**  
**65% MCP (or FULL THROTTLE) - 2600 POUNDS**

5-24

**Section V**  
**Performance**

**DEECHCRAFT**  
**Sierra C24R**

November, 1980

| PRESS<br>ALT. | ISA -36°F (-20°C) |               |              |     |     |               | STANDARD DAY (ISA) |     |     |               |              |     | ISA +36°F (+20°C) |               |              |     |       |               |              |     |     |               |              |       |     |     |     |     |
|---------------|-------------------|---------------|--------------|-----|-----|---------------|--------------------|-----|-----|---------------|--------------|-----|-------------------|---------------|--------------|-----|-------|---------------|--------------|-----|-----|---------------|--------------|-------|-----|-----|-----|-----|
|               | OAT               | MAN.<br>PRESS | FUEL<br>FLOW | TAS | OAT | MAN.<br>PRESS | FUEL<br>FLOW       | TAS | OAT | MAN.<br>PRESS | FUEL<br>FLOW | TAS | OAT               | MAN.<br>PRESS | FUEL<br>FLOW | TAS | OAT   | MAN.<br>PRESS | FUEL<br>FLOW | TAS | OAT | MAN.<br>PRESS | FUEL<br>FLOW | TAS   |     |     |     |     |
| FEET          | °F                | °C            | IN HG        | PPH | GPH | KTS           | MPH                | °F  | °C  | IN HG         | PPH          | GPH | KTS               | MPH           | °F           | °C  | IN HG | PPH           | GPH          | KTS | MPH | °F            | °C           | IN HG | PPH | GPH | KTS | MPH |
| SL            | 25                | -4            | 223          | 54  | 9.0 | 116           | 134                | 61  | 16  | 229           | 54           | 9.0 | 118               | 136           | 97           | 36  | 235   | 54            | 9.0          | 120 | 138 | 25            | 16           | 222   | 54  | 9.0 | 125 | 144 |
| 1000          | 21                | -6            | 220          | 54  | 9.0 | 117           | 135                | 57  | 14  | 226           | 54           | 9.0 | 119               | 137           | 93           | 34  | 232   | 54            | 9.0          | 121 | 139 | 21            | 14           | 220   | 54  | 9.0 | 126 | 145 |
| 2000          | 18                | -8            | 217          | 54  | 9.0 | 118           | 136                | 54  | 12  | 223           | 54           | 9.0 | 120               | 138           | 90           | 32  | 230   | 54            | 9.0          | 122 | 140 | 18            | 10           | 218   | 54  | 9.0 | 123 | 142 |
| 3000          | 14                | -10           | 215          | 54  | 9.0 | 118           | 136                | 50  | 10  | 221           | 54           | 9.0 | 121               | 139           | 86           | 30  | 227   | 54            | 9.0          | 123 | 142 | 14            | 8            | 218   | 54  | 9.0 | 124 | 143 |
| 4000          | 10                | -12           | 212          | 54  | 9.0 | 119           | 137                | 46  | 8   | 218           | 54           | 9.0 | 122               | 140           | 84           | 29  | 224   | 54            | 9.0          | 124 | 143 | 10            | 12           | 218   | 54  | 9.0 | 125 | 144 |
| 5000          | 7                 | -14           | 209          | 54  | 9.0 | 120           | 138                | 43  | 6   | 215           | 54           | 9.0 | 123               | 142           | 81           | 27  | 222   | 54            | 9.0          | 125 | 144 | 7             | 14           | 215   | 54  | 9.0 | 126 | 145 |
| 6000          | 3                 | -16           | 207          | 54  | 9.0 | 121           | 139                | 41  | 5   | 213           | 54           | 9.0 | 124               | 143           | 77           | 25  | 220   | 54            | 9.0          | 126 | 145 | 3             | 16           | 213   | 54  | 9.0 | 127 | 146 |
| 7000          | 1                 | -17           | 205          | 54  | 9.0 | 122           | 140                | 37  | 3   | 211           | 54           | 9.0 | 125               | 144           | 73           | 23  | 217   | 54            | 9.0          | 126 | 145 | 1             | 17           | 205   | 54  | 9.0 | 127 | 146 |
| 8000          | -2                | -19           | 203          | 54  | 9.0 | 123           | 142                | 34  | 1   | 204           | 54           | 9.0 | 125               | 144           | 70           | 21  | 215   | 54            | 9.0          | 127 | 146 | -2            | -19          | 203   | 54  | 9.0 | 128 | 147 |
| 9000          | -6                | 21            | 201          | 54  | 9.0 | 124           | 143                | 30  | -1  | 207           | 54           | 9.0 | 126               | 145           | 66           | 19  | 213   | 54            | 9.0          | 127 | 146 | -6            | 21           | 201   | 54  | 9.0 | 128 | 147 |
| 10000         | -9                | 23            | 199          | 54  | 9.0 | 125           | 144                | 27  | -3  | 205           | 54           | 9.0 | 127               | 146           | 63           | 17  | 208   | 53            | 8.8          | 127 | 146 | -9            | 23           | 199   | 54  | 9.0 | 128 | 147 |
| 11000         | -13               | 25            | 198          | 54  | 9.0 | 125           | 144                | 23  | -5  | 201           | 53           | 8.8 | 126               | 145           | 59           | 15  | 201   | 52            | 8.7          | 126 | 145 | -13           | 25           | 198   | 54  | 9.0 | 129 | 148 |
| 12000         | -17               | 27            | 193          | 54  | 9.0 | 125           | 144                | 19  | -7  | 19.3          | 52           | 8.7 | 125               | 144           | 55           | 13  | 19.3  | 51            | 8.5          | 123 | 142 | -17           | 27           | 193   | 54  | 9.0 | 129 | 148 |
| 13000         | -20               | 29            | 186          | 52  | 8.7 | 124           | 143                | 16  | -9  | 18.6          | 51           | 8.5 | 123               | 142           | 52           | 11  | 18.6  | 49            | 8.2          | 120 | 138 | -20           | 29           | 186   | 52  | 8.7 | 120 | 138 |
| 14000         | -24               | 31            | 179          | 51  | 8.5 | 121           | 139                | 12  | -11 | 17.9          | 49           | 8.2 | 120               | 138           | 48           | 9   | 17.9  | 48            | 8.0          | 117 | 135 | -24           | 31           | 179   | 51  | 8.5 | 121 | 139 |

NOTES 1 Shaded area represents operation with full throttle  
 2 Full throttle manifold settings are approximate

November, 1980

**CRUISE POWER SETTINGS - 2400 RPM**  
**55% MCP - 2600 POUNDS**

5-25

| PRESS<br>ALT. | ISA -36°F (-20°C) |               |              |     |     |               | STANDARD DAY (ISA) |     |     |               |              |     | ISA +36°F (+20°C) |               |              |     |       |               |              |     |     |               |              |       |     |     |     |     |
|---------------|-------------------|---------------|--------------|-----|-----|---------------|--------------------|-----|-----|---------------|--------------|-----|-------------------|---------------|--------------|-----|-------|---------------|--------------|-----|-----|---------------|--------------|-------|-----|-----|-----|-----|
|               | OAT               | MAN.<br>PRESS | FUEL<br>FLOW | TAS | OAT | MAN.<br>PRESS | FUEL<br>FLOW       | TAS | OAT | MAN.<br>PRESS | FUEL<br>FLOW | TAS | OAT               | MAN.<br>PRESS | FUEL<br>FLOW | TAS | OAT   | MAN.<br>PRESS | FUEL<br>FLOW | TAS | OAT | MAN.<br>PRESS | FUEL<br>FLOW | TAS   |     |     |     |     |
| FEET          | °F                | °C            | IN HG        | PPH | GPH | KTS           | MPH                | °F  | °C  | IN HG         | PPH          | GPH | KTS               | MPH           | °F           | °C  | IN HG | PPH           | GPH          | KTS | MPH | °F            | °C           | IN HG | PPH | GPH | KTS | MPH |
| SL            | 25                | -4            | 197          | 48  | 8.0 | 106           | 122                | 61  | 16  | 203           | 48           | 8.0 | 106               | 124           | 97           | 36  | 208   | 48            | 8.0          | 110 | 127 | 25            | 16           | 203   | 48  | 8.0 | 112 | 130 |
| 1000          | 21                | -6            | 196          | 48  | 8.0 | 107           | 123                | 57  | 14  | 201           | 48           | 8.0 | 108               | 124           | 93           | 34  | 206   | 48            | 8.0          | 110 | 127 | 21            | 14           | 201   | 48  | 8.0 | 111 | 128 |
| 2000          | 18                | -8            | 193          | 48  | 8.0 | 107           | 123                | 54  | 12  | 19.8          | 48           | 8.0 | 109               | 125           | 90           | 32  | 203   | 48            | 8.0          | 111 | 129 | 18            | 10           | 19.6  | 48  | 8.0 | 112 | 129 |
| 3000          | 14                | -10           | 191          | 48  | 8.0 | 108           | 124                | 50  | 10  | 19.6          | 48           | 8.0 | 110               | 127           | 86           | 30  | 201   | 48            | 8.0          | 112 | 129 | 14            | 8            | 19.4  | 48  | 8.0 | 113 | 130 |
| 4000          | 10                | -12           | 189          | 48  | 8.0 | 109           | 125                | 46  | 8   | 19.4          | 48           | 8.0 | 111               | 126           | 82           | 28  | 19.9  | 48            | 8.0          | 113 | 130 | 10            | 6            | 19.1  | 48  | 8.0 | 114 | 131 |
| 5000          | 7                 | -14           | 186          | 48  | 8.0 | 110           | 127                | 43  | 6   | 19.1          | 48           | 8.0 | 112               | 129           | 79           | 26  | 19.7  | 48            | 8.0          | 113 | 130 | 7             | 4            | 18.9  | 48  | 8.0 | 114 | 131 |
| 6000          | 3                 | -16           | 184          | 48  | 8.0 | 111           | 128                | 39  | 4   | 18.9          | 48           | 8.0 | 113               | 130           | 75           | 24  | 19.4  | 48            | 8.0          | 114 | 131 | 3             | 16           | 184   | 48  | 8.0 | 115 | 132 |
| 7000          | 0                 | -18           | 182          | 48  | 8.0 | 111           | 128                | 36  | 2   | 18.7          | 48           | 8.0 | 113               | 130           | 72           | 22  | 19.2  | 48            | 8.0          | 115 | 132 | 0             | 18           | 182   | 48  | 8.0 | 116 | 132 |
| 8000          | -4                | 20            | 180          | 48  | 8.0 | 112           | 129                | 32  | 0   | 18.5          | 48           | 8.0 | 114               | 131           | 68           | 20  | 19.1  | 48            | 8.0          | 115 | 132 | -4            | 20           | 180   | 48  | 8.0 | 116 | 134 |
| 9000          | -8                | 22            | 178          | 48  | 8.0 | 113           | 130                | 28  | -2  | 18.3          | 48           | 8.0 | 114               | 131           | 64           | 18  | 18.9  | 48            | 8.0          | 116 | 134 | -8            | 22           | 178   | 48  | 8.0 | 117 | 135 |
| 10000         | -11               | 24            | 176          | 48  | 8.0 | 114           | 131                | 25  | -4  | 18.1          | 48           | 8.0 | 115               | 132           | 61           | 16  | 18.7  | 48            | 8.0          | 116 | 134 | -11           | 24           | 176   | 48  | 8.0 | 118 | 135 |
| 11000         | -15               | 26            | 175          | 48  | 8.0 | 114           | 131                | 21  | -6  | 18.0          | 48           | 8.0 | 116               | 134           | 57           | 14  | 18.5  | 48            | 8.0          | 117 | 135 | -15           | 26           | 175   | 48  | 8.0 | 119 | 135 |
| 12000         | -18               | 28            | 173          | 48  | 8.0 | 115           | 132                | 18  | -8  | 17.8          | 48           | 8.0 | 116               | 134           | 55           | 13  | 18.3  | 48            | 8.0          | 117 | 135 | -18           | 28           | 173   | 48  | 8.0 | 120 | 135 |
| 13000         | -22               | 30            | 171          | 48  | 8.0 | 115           | 132                | 14  | -10 | 17.6          | 48           | 8.0 | 116               | 134           | 50           | 10  | 18.1  | 48            | 8.0          | 117 | 135 | -22           | 30           | 171   | 48  | 8.0 | 121 | 135 |
| 14000         | -26               | 32            | 168          | 48  | 8.0 | 116           | 134                | 10  | -12 | 17.4          | 48           | 8.0 | 117               | 135           | 46           | 8   | 18.0  | 48            | 8.0          | 117 | 135 | -26           | 32           | 168   | 48  | 8.0 | 122 | 135 |

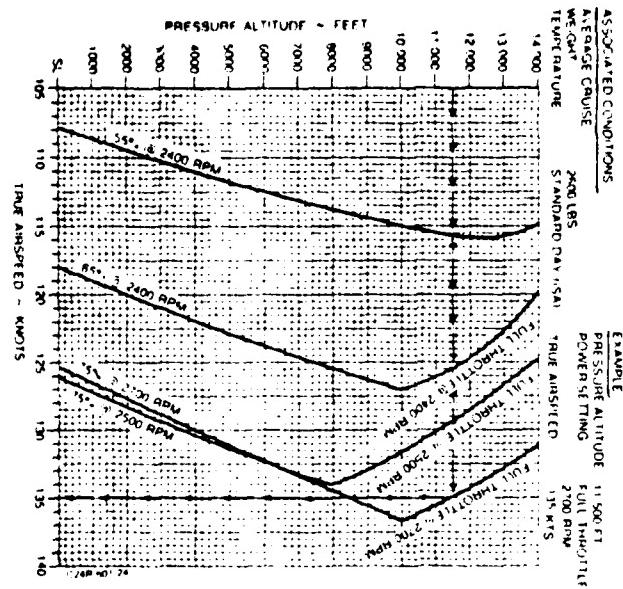
**Section V**  
**Performance**

**Section V**  
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Sierra C24R

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**Section V**  
**Performance**



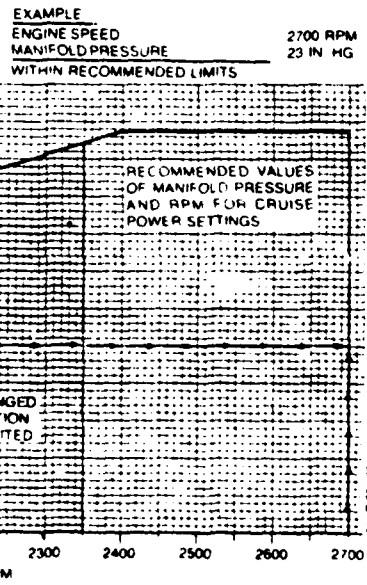
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**MANIFOLD PRESSURE vs RPM**



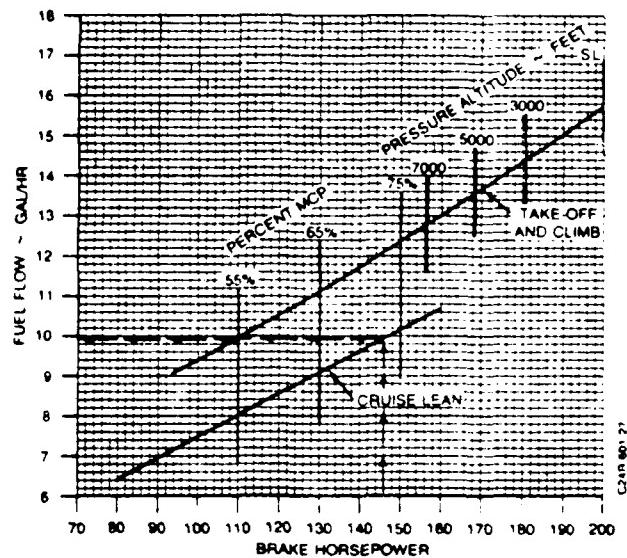
Section V  
Performance

BEECHCRAFT  
Sierra C24R

FUEL FLOW vs BRAKE HORSEPOWER

EXAMPLE

|                               |                                       |
|-------------------------------|---------------------------------------|
| BRAKE HORSEPOWER<br>CONDITION | 146 HP<br>LEVEL FLIGHT<br>CRUISE LEAN |
| FUEL FLOW                     | 9.95 GAL/HR                           |



BEECHCRAFT  
Sierra C24R

Section V  
Performance

BEECHCRAFT  
Sierra C24R

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Performance

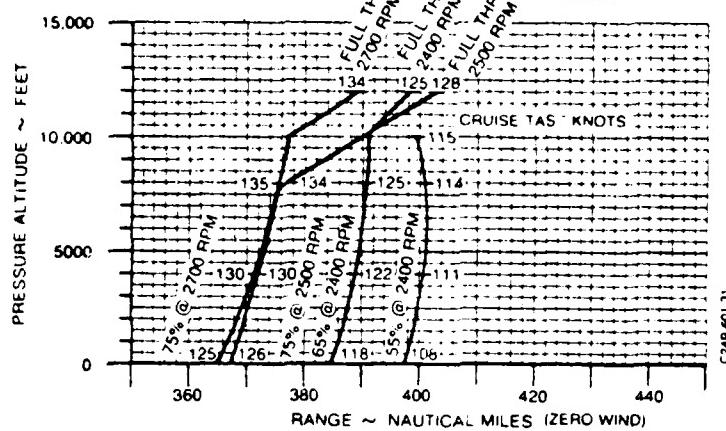
### RANGE PROFILE - 37 GALLONS

#### ASSOCIATED CONDITIONS

#### STANDARD DAY

WEIGHT 2758 LBS BEFORE ENGINE START  
FUEL 100 OCTANE AVIATION GASOLINE  
FUEL DENSITY 6.0 LBS/GAL  
INITIAL FUEL  
LOADING 37 U.S. GAL (222 LBS)

NOTE  
RANGE INCLUDES START, TAXI,  
CLIMB WITH 45 MINUTES RESERVE  
FUEL AT 55% MAXIMUM CONTINUOUS  
POWER



November, 1980

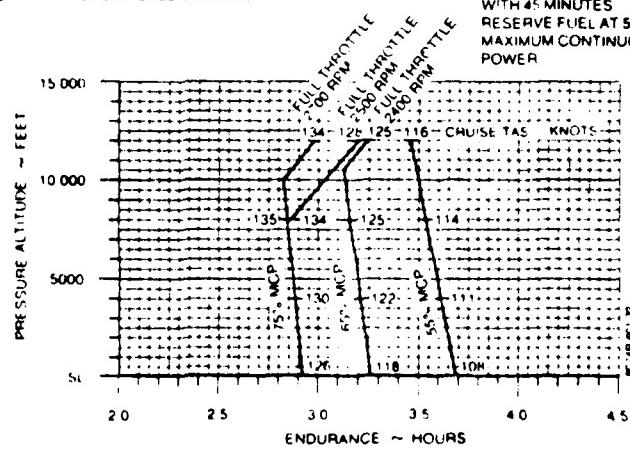
5-29

#### ASSOCIATED CONDITIONS

#### ENDURANCE PROFILE - 37 GALLONS

WEIGHT 2758 LBS BEFORE ENGINE START  
FUEL 100 OCTANE AVIATION GASOLINE  
FUEL DENSITY 6.0 LBS/GAL  
INITIAL FUEL  
LOADING 37 U.S. GALS (222 LBS)

STANDARD DAY  
NOTE  
ENDURANCE INCLUDES  
START, TAXI, AND CLIMB.  
WITH 45 MINUTES  
RESERVE FUEL AT 55%  
MAXIMUM CONTINUOUS  
POWER



November, 1980

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Section V  
Performance

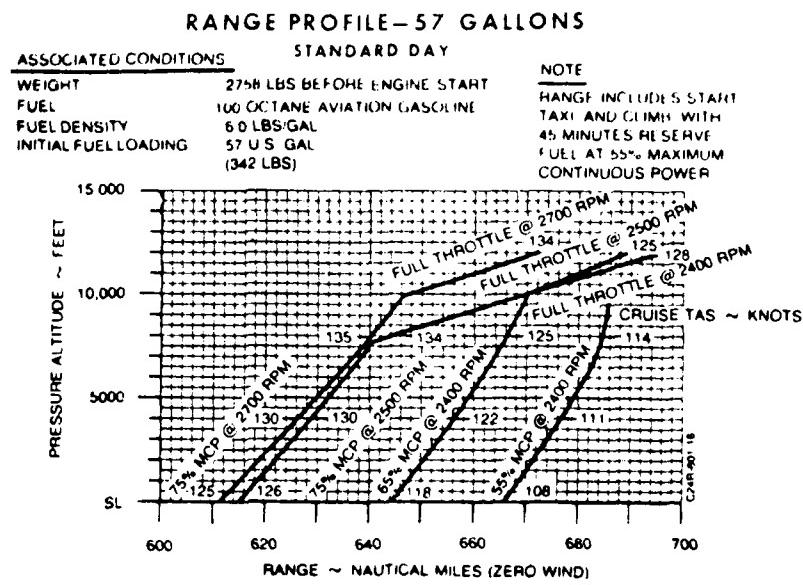
BEECHCRAFT  
Sierra C24R

Section V  
Performance

BEECHCRAFT  
Sierra C24R

5-30

November, 1980



5-32

November, 1980

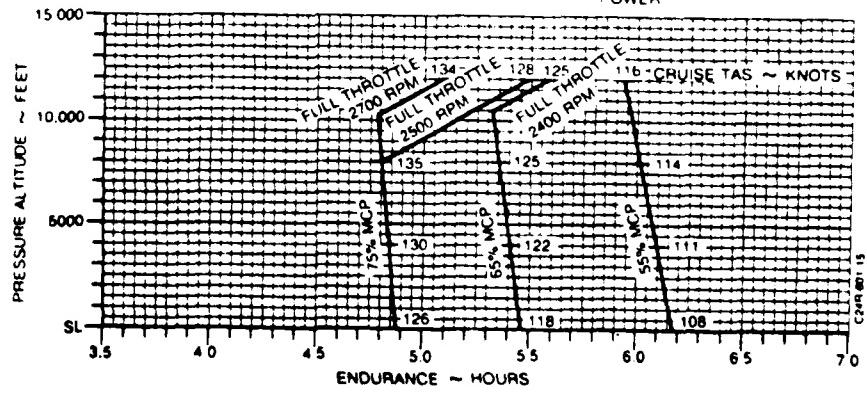
**ENDURANCE PROFILE - 57 GALLONS**  
STANDARD DAY (ISA)

**ASSOCIATED CONDITIONS**

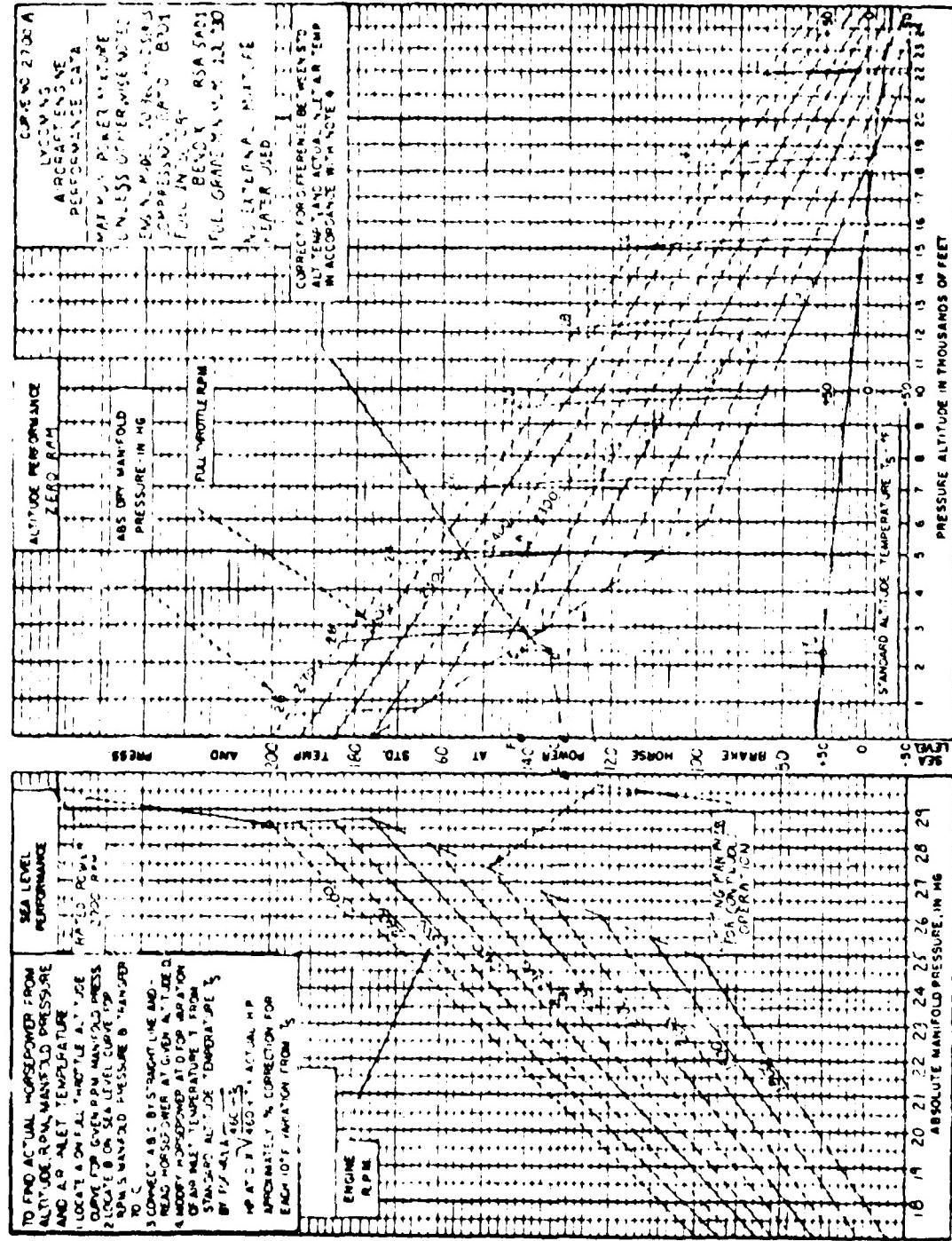
|                      |                              |
|----------------------|------------------------------|
| WEIGHT               | 2758 LBS BEFORE ENGINE START |
| FUEL                 | 100 OCTANE AVIATION GASOLINE |
| FUEL DENSITY         | 6.0 LBS/GAL                  |
| INITIAL FUEL LOADING | 57 U.S. GAL (342 LBS)        |

**NOTE**

ENDURANCE INCLUDES START TAXI AND CLIMB WITH 45 MINUTES RESERVE FUEL AT 55% MAXIMUM CONTINUOUS POWER



IV. Engine Data



Data Source: Courtesy of AVCO Lycoming Williamsport Division

$$J = \frac{VTAS(fps)}{ND_p} 60$$

**NOTE:** Reduce efficiency by 5% for installation blockage effect.

$$C_7 = \frac{550 \text{ BHP}_t (60)^3}{N = RPM}$$

$D_p$  = propeller diameter (ft)

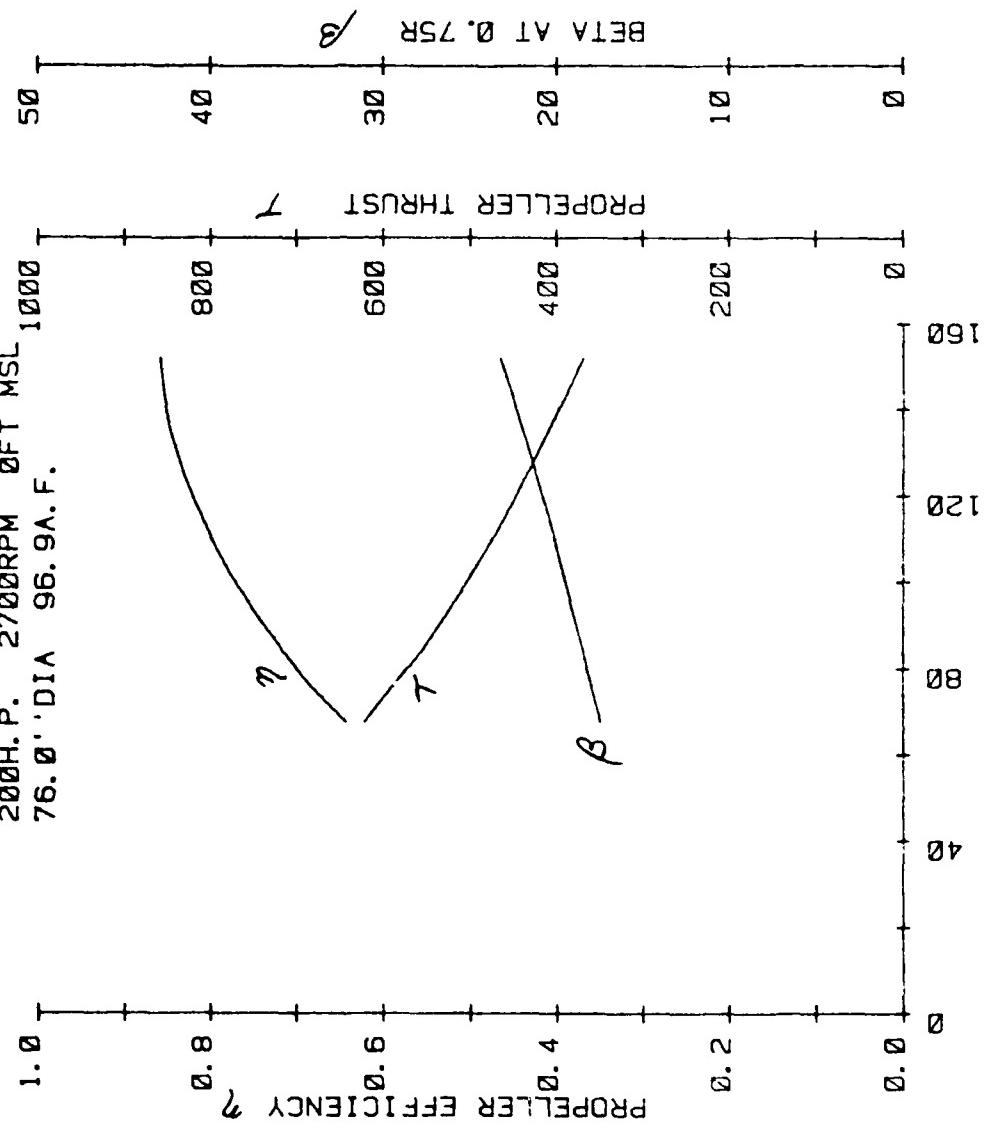
Data Source: Courtesy of TRW Hartzell Propeller

ESTIMATED PERFORMANCE

HC-M2YR-1BF/F7666A

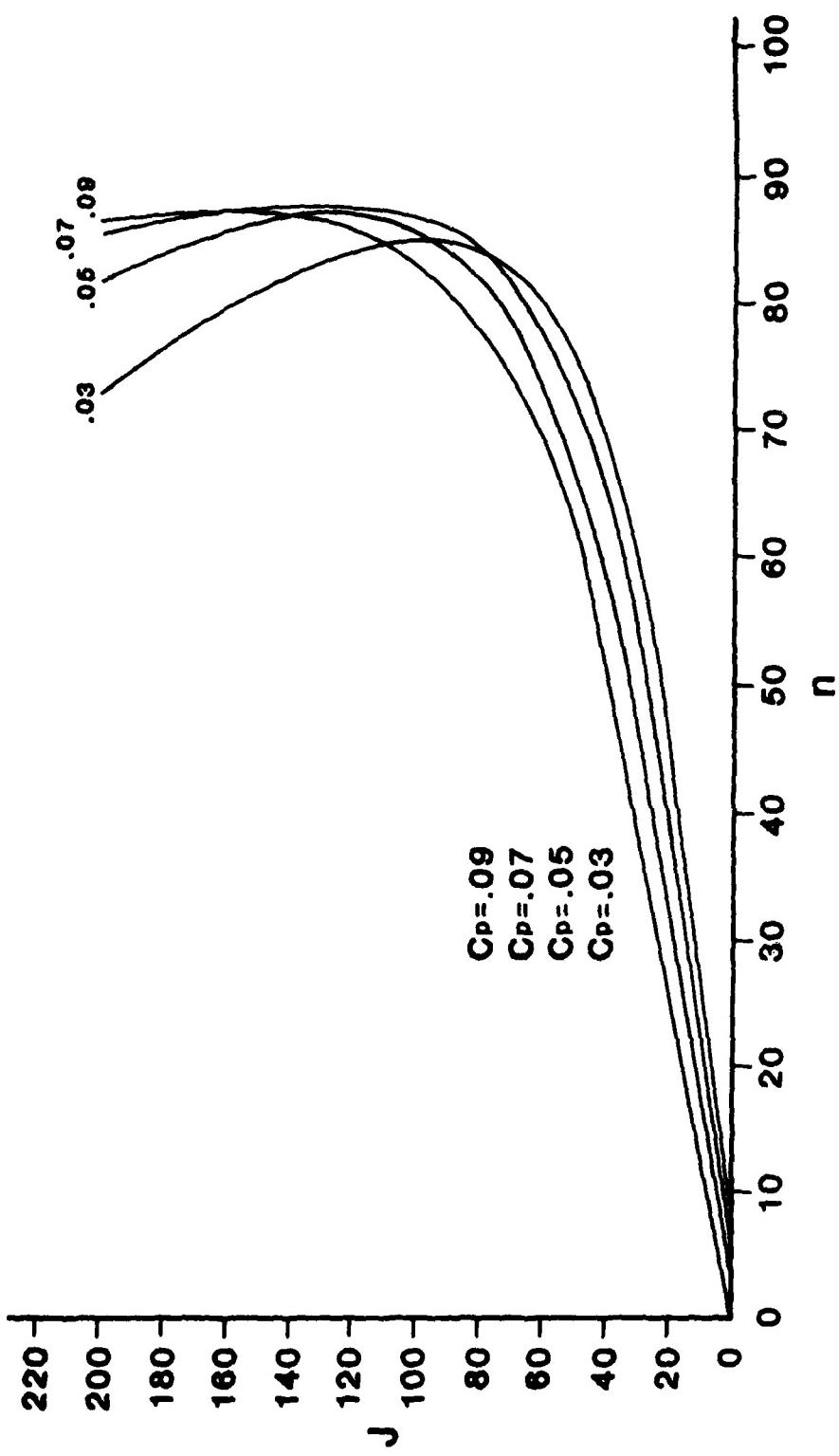
Lyc. 10-360-A1B6

2000H. P. 2700RPM 0FT MSL 76.0' DIA 96.9A. F.



Data Source: Courtesy of TRW Hartzell Propeller

**Advance Ratio vs Efficiency  
Given values of  $C_p$**



IV. WEIGHT AND BALANCE

BASIC EMPTY WEIGHT AND BALANCE  
 SIERA 200 C24R SER. NO. MC-513 REG. NO. N18892 DATE 10-9-80

JACK POINT LOCATION  
 FORWARD 129.2 Company  
 AFT 285.9 Signature

| REACTION<br>WHEEL - JACK POINTS  | SCALE<br>READING | TARE   | NET<br>WEIGHT | ARM               | MOMENT                    |
|--|------------------|--------|---------------|-------------------|---------------------------|
| LEFT MAIN  | 674.5            |        |               |                   |                           |
| RIGHT MAIN   | 662.0            |        |               |                   |                           |
| NOSE OR TAIL   | 442.5            |        |               |                   |                           |
| TOTAL (AS WEIGHED)   | 1779.0           |        | 1779.0        | 129.251<br>57.313 | 172744<br>25361<br>198105 |
| <i>Space below provided for additions and subtractions to as - weighed condition</i> |                  |        |               |                   |                           |
| LESS 8 QT OIL  |                  | - 15.0 | 50            | - 750             |                           |
| Plus: Fire Extinguisher  |                  | + 2.7  | 107.0         | 288.9             |                           |
| ELT  |                  | + .6   | 259.0         | 155.4             |                           |
| EMPTY WEIGHT   | 1767.3           | 111.92 | 197799        |                   |                           |
| ENGINE OIL   | 15.0             | 50.0   | 750           |                   |                           |
| UNUSABLE FUEL  | 15.6             | 125.0  | 1950          |                   |                           |
| BASIC EMPTY WEIGHT   | 1797.9           | 111.52 | 200499        |                   |                           |

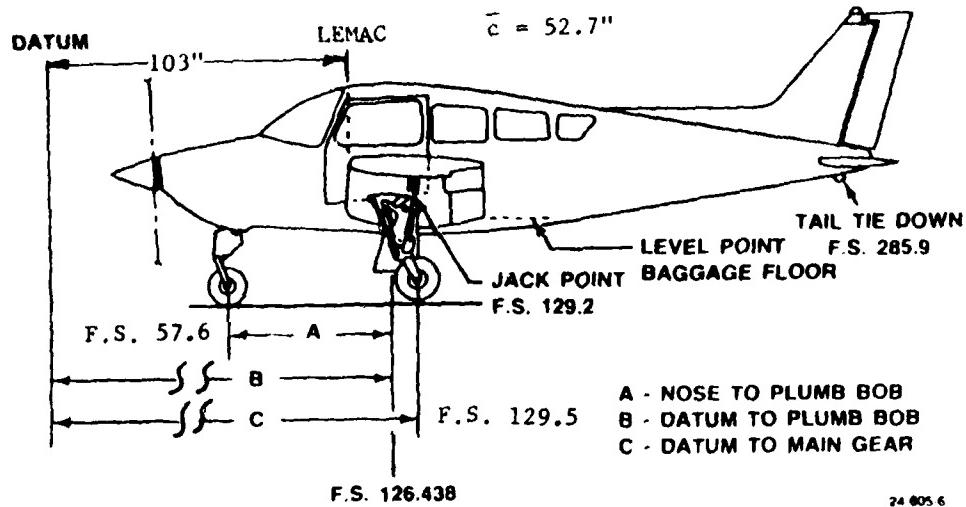
BASIC EMPTY WEIGHT AND BALANCE  
 SIERA 200 C24R SER. NO. MC-690 REG. NO. N6636D DATE 10-9-80

JACK POINT LOCATION  
 FORWARD 129.2 Company  
 AFT 285.9 Signature

| REACTION<br>WHEEL - JACK POINTS  | SCALE<br>READING | TARE   | NET<br>WEIGHT | ARM               | MOMENT                    |
|--|------------------|--------|---------------|-------------------|---------------------------|
| LEFT MAIN  | 719.0            |        |               |                   |                           |
| RIGHT MAIN   | 717.5            |        |               |                   |                           |
| NOSE OR TAIL   | 396.0            |        |               |                   |                           |
| TOTAL (AS WEIGHED)   | 1832.5           |        | 1832.5        | 129.188<br>56.563 | 185579<br>22399<br>207978 |
| <i>Space below provided for additions and subtractions to as - weighed condition</i> |                  |        |               |                   |                           |
| LESS 8 QT OIL  |                  | - 15.0 | 50            | - 750             |                           |
| Less Aft Ballast Weight  |                  | - 10.1 | 288.42        | 2913              |                           |
| Plus: ELT  |                  | + 2.7  | 259.0         | + 699             |                           |
| ELT (correction)   |                  | + 1.0  | 259.0         | + 259             |                           |
| Fire Extinguisher  |                  | + 5.0  | 126.0         | + 630             |                           |
| EMPTY WEIGHT   | 1816.1           | 113.38 | 205903        |                   |                           |
| ENGINE OIL   | 15.0             | 50.0   | 750           |                   |                           |
| UNUSABLE FUEL  | 15.6             | 125.0  | 1950          |                   |                           |
| BASIC EMPTY WEIGHT   | 1846.7           | 112.96 | 208603        |                   |                           |

Section VI  
Wt & Bal Equip List

BEECHCRAFT  
Sierra C24R

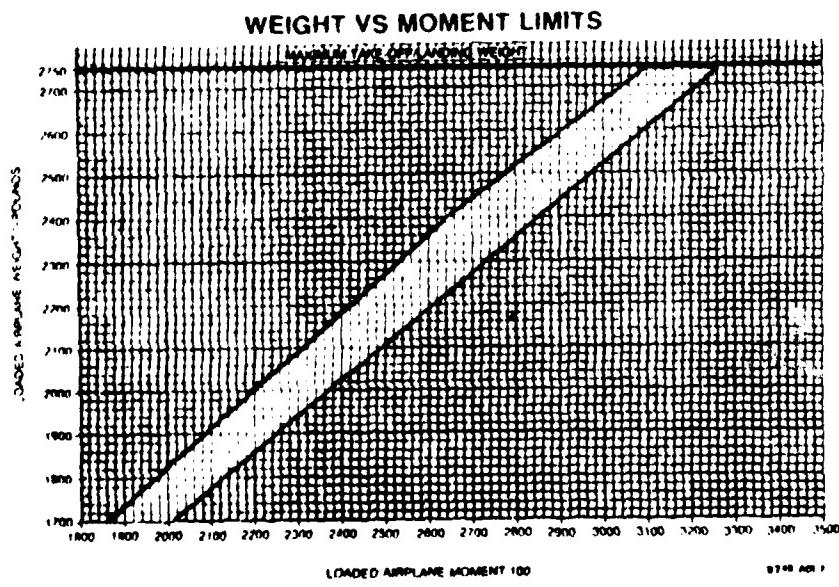


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Section VI  
Wt & Bal Equip List

BEECHCRAFT  
Sierra C24R



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BEECHCRAFT  
Sierra C24R

Section VI  
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MOMENT LIMITS vs WEIGHT

|      | Minimum Moment<br>Weight 100 | Maximum Moment<br>Weight 100 |      | Minimum Moment<br>Weight 100 | Maximum Moment<br>Weight 100 |      | Minimum Moment<br>Weight 100 | Maximum Moment<br>Weight 100 |
|------|------------------------------|------------------------------|------|------------------------------|------------------------------|------|------------------------------|------------------------------|
| 1700 | 1820                         | 2011                         | 2100 | 2310                         | 2484                         | 2500 | 2775                         | 2956                         |
| 1710 | 1883                         | 2023                         | 2110 | 2321                         | 2496                         | 2510 | 2788                         | 2969                         |
| 1720 | 1892                         | 2036                         | 2120 | 2332                         | 2508                         | 2520 | 2801                         | 2981                         |
| 1730 | 1903                         | 2047                         | 2130 | 2343                         | 2520                         | 2530 | 2814                         | 2993                         |
| 1740 | 1914                         | 2056                         | 2140 | 2354                         | 2532                         | 2540 | 2826                         | 3005                         |
| 1750 | 1924                         | 2070                         | 2150 | 2365                         | 2543                         | 2550 | 2841                         | 3047                         |
| 1760 | 1936                         | 2082                         | 2160 | 2376                         | 2555                         | 2560 | 2854                         | 3028                         |
| 1770 | 1947                         | 2094                         | 2170 | 2387                         | 2567                         | 2570 | 2867                         | 3040                         |
| 1780 | 1958                         | 2106                         | 2180 | 2398                         | 2579                         | 2580 | 2880                         | 3052                         |
| 1790 | 1969                         | 2118                         | 2190 | 2409                         | 2591                         | 2590 | 2894                         | 3064                         |
| 1800 | 1980                         | 2129                         | 2200 | 2420                         | 2603                         | 2600 | 2907                         | 3076                         |
| 1810 | 1991                         | 2141                         | 2210 | 2431                         | 2614                         | 2610 | 2920                         | 3086                         |
| 1820 | 2002                         | 2153                         | 2220 | 2442                         | 2626                         | 2620 | 2932                         | 3099                         |
| 1830 | 2013                         | 2165                         | 2230 | 2453                         | 2638                         | 2630 | 2947                         | 3111                         |
| 1840 | 2024                         | 2177                         | 2240 | 2464                         | 2650                         | 2640 | 2960                         | 3123                         |
| 1850 | 2035                         | 2189                         | 2250 | 2475                         | 2662                         | 2650 | 2973                         | 3135                         |
| 1860 | 2046                         | 2200                         | 2260 | 2486                         | 2674                         | 2660 | 2987                         | 3147                         |
| 1870 | 2057                         | 2212                         | 2270 | 2497                         | 2685                         | 2670 | 3000                         | 3159                         |
| 1880 | 2068                         | 2224                         | 2280 | 2508                         | 2697                         | 2680 | 3013                         | 3170                         |
| 1890 | 2079                         | 2236                         | 2290 | 2519                         | 2709                         | 2690 | 3027                         | 3182                         |
| 1900 | 2090                         | 2248                         | 2300 | 2530                         | 2721                         | 2700 | 3040                         | 3194                         |
| 1910 | 2101                         | 2260                         | 2310 | 2541                         | 2733                         | 2710 | 3054                         | 3206                         |
| 1920 | 2112                         | 2271                         | 2320 | 2552                         | 2745                         | 2720 | 3067                         | 3218                         |
| 1930 | 2123                         | 2283                         | 2330 | 2563                         | 2756                         | 2730 | 3081                         | 3230                         |
| 1940 | 2134                         | 2295                         | 2340 | 2574                         | 2768                         | 2740 | 3094                         | 3241                         |
| 1950 | 2145                         | 2307                         | 2350 | 2585                         | 2780                         | 2750 | 3108                         | 3253                         |
| 1960 | 2156                         | 2319                         | 2360 | 2596                         | 2792                         |      |                              |                              |
| 1970 | 2167                         | 2331                         | 2370 | 2607                         | 2804                         |      |                              |                              |
| 1980 | 2178                         | 2342                         | 2380 | 2619                         | 2815                         |      |                              |                              |
| 1990 | 2189                         | 2354                         | 2390 | 2632                         | 2827                         |      |                              |                              |
| 2000 | 2200                         | 2366                         | 2400 | 2645                         | 2839                         |      |                              |                              |
| 2010 | 2211                         | 2378                         | 2410 | 2658                         | 2851                         |      |                              |                              |
| 2020 | 2222                         | 2390                         | 2420 | 2671                         | 2863                         |      |                              |                              |
| 2030 | 2233                         | 2401                         | 2430 | 2684                         | 2875                         |      |                              |                              |
| 2040 | 2244                         | 2413                         | 2440 | 2697                         | 2887                         |      |                              |                              |
| 2050 | 2255                         | 2425                         | 2450 | 2710                         | 2898                         |      |                              |                              |
| 2060 | 2266                         | 2437                         | 2460 | 2721                         | 2910                         |      |                              |                              |
| 2070 | 2277                         | 2449                         | 2470 | 2736                         | 2922                         |      |                              |                              |
| 2080 | 2288                         | 2461                         | 2480 | 2749                         | 2934                         |      |                              |                              |
| 2090 | 2299                         | 2472                         | 2490 | 2762                         | 2946                         |      |                              |                              |

The above weight and moment limits are based on the following weight and center of gravity limit data:

NORMAL CATEGORY

| WEIGHT CONDITION                  | FWD CG LIMIT | AFT CG LIMIT |
|-----------------------------------|--------------|--------------|
| 2750 lb (Max Take-Off or Landing) | 113.0        | 118.3        |
| 2375 lb or less                   | 110.0        | 116.3        |

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Section VI  
Wt & Bal/Equip List

BEECHCRAFT  
Sierra C24R

**COMPUTING PROCEDURE**

1 Record the Basic Empty Weight and Moment from the Basic Empty Weight and Balance form (or from the latest superseding form) under the Basic Empty Condition block. The moment must be divided by 100 to correspond to Useful Load Weights and Moments tables.

2 Record the weight and corresponding moment from the appropriate table of each of the useful load items (except fuel) to be carried in the airplane.

3 Total the weight column and moment column. The SUB-TOTALS are the ZERO FUEL CONDITION

4 Determine the weight and corresponding moment for the fuel loading to be used. This fuel loading includes fuel for the flight, plus that required for start, taxi, and takeoff. Add the Fuel Loading Condition to Zero Fuel Condition to obtain the SUB-TOTAL Ramp Condition.

5 Subtract the fuel to be used for start, taxi, and takeoff to arrive at the SUB-TOTAL Take-off Condition.

6 Subtract the weight and moment of fuel to be used from the take-off weight and moment. The SUB-TOTAL Condition of No. 3 and No. 5, as well as the landing condition moment, must be within the minimum and maximum moments shown on the Moment Limits vs Weight graph for that weight. If the total moment is less than the minimum moment allowed, useful load items must be shifted aft, or forward load items reduced. If the total moment is greater than the maximum moment allowed, useful load items must be shifted forward, or aft load items reduced. If the quantity or location of load items is changed, the calculations must be revised and the moments rechecked.

BEECHCRAFT  
Sierra C24R

Section VI  
Wt & Bal Equip List

WEIGHT AND BALANCE LOADING FORM

MODEL SIERRA C24R DATE XX-XX

SERIAL NO. XXX REG. NO. XXXXXX

| ITEM  | WEIGHT | MOM/100 |
|---|--------|---------|
| 1 BASIC EMPTY CONDITION                         | 1720   | 1912    |
| 2 FRONT SEAT OCCUPANTS                          | 340    | 374     |
| 3 3rd & 4th SEAT OCCUPANTS                      | 340    | 482     |
| 4 5th & 6th SEAT OCCUPANTS                      | 130    | 222     |
| 5 BAGGAGE                                       | —      | —       |
| 6 CARGO   | —      | —       |
| 7 SUB TOTAL                                     | 2530   | 2440    |
| 8 FUEL LOADING (32 gal)                         | 192    | 228     |
| 9. SUB TOTAL<br>RAMP CONDITION                  | 2722   | 3215    |
| 10. *LESS FUEL FOR START,<br>TAXI, and TAKE-OFF | .8     | .9      |
| 11. SUB TOTAL<br>TAKE-OFF CONDITION             | 2714   | 3206    |
| 12. LESS FUEL TO<br>DESTINATION (25 gal)        | -150   | -176    |
| 13. LANDING CONDITION                           | 2564   | 3030    |

\*Fuel for start, taxi and take-off is normally 8 lbs at an average mom/100 of 9.

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Section VI  
Wt & Bal Equip List

BEECHCRAFT  
Sierra C24R

WEIGHT AND BALANCE LOADING FORM

MODEL SIERRA C24R DATE \_\_\_\_\_

SERIAL NO. \_\_\_\_\_ REG. NO. \_\_\_\_\_

| ITEM  | WEIGHT | MOM/100 |
|---|--------|---------|
| 1. BASIC EMPTY CONDITION                        |        |         |
| 2. FRONT SEAT OCCUPANTS                         |        |         |
| 3. 3rd & 4th SEAT OCCUPANTS                     |        |         |
| 4. 5th & 6th SEAT OCCUPANTS                     |        |         |
| 5. BAGGAGE                                      |        |         |
| 6. CARGO  |        |         |
| 7. SUB TOTAL                                    |        |         |
| 8. FUEL LOADING                                 |        |         |
| 9. SUB TOTAL                                    |        |         |
| 10. *LESS FUEL FOR START,<br>TAXI, AND TAKE-OFF |        |         |
| 11. SUB TOTAL                                   |        |         |
| 12. LESS FUEL TO<br>DESTINATION                 |        |         |
| 13. LANDING CONDITION                           |        |         |

\*Fuel for start, taxi and take-off is normally 8 lbs at an average mom/100 of 9.

November, 1960

BEECHCRAFT  
Sierra C24R

WEIGHT AND BALANCE LOADING FORM

MODEL SIERRA C24R DATE \_\_\_\_\_

SERIAL NO. \_\_\_\_\_ REG. NO. \_\_\_\_\_

| ITEM  | WEIGHT | MOM/100 |
|---|--------|---------|
| 1. BASIC EMPTY CONDITION                        |        |         |
| 2. FRONT SEAT OCCUPANTS                         |        |         |
| 3. 3rd & 4th SEAT OCCUPANTS                     |        |         |
| 4. 5th & 6th SEAT OCCUPANTS                     |        |         |
| 5. BAGGAGE                                      |        |         |
| 6. CARGO  |        |         |
| 7. SUB TOTAL                                    |        |         |
| 8. FUEL LOADING                                 |        |         |
| 9. SUB TOTAL                                    |        |         |
| 10. *LESS FUEL FOR START,<br>TAXI, AND TAKE-OFF |        |         |
| 11. SUB TOTAL                                   |        |         |
| 12. LESS FUEL TO<br>DESTINATION                 |        |         |
| 13. LANDING CONDITION                           |        |         |

\*Fuel for start, taxi and take-off is normally 8 lbs at an average mom/100 of 9.

November, 1960

BEECHCRAFT  
Sierra C24R

Section VI  
Wt & Bal/Equip List

USEFUL LOAD WEIGHTS AND MOMENTS

OCCUPANTS

| WEIGHT | FRONT SEATS |     | 3RD AND 4TH SEATS |     | SPLIT SEAT |     |
|--------|-------------|-----|-------------------|-----|------------|-----|
|        | FWD POS.    |     | AFT POS.          |     | ARM        |     |
|        | 'ARM        | MOM | 'ARM              | MOM | MOM        | MOM |
| 120    | 104         | 100 | 105               | 100 | 112        | 142 |
| 130    | 125         | 126 | 135               | 137 | 134        | 142 |
| 140    | 146         | 147 | 146               | 147 | 146        | 144 |
| 150    | 156         | 158 | 156               | 158 | 157        | 144 |
| 160    | 166         | 168 | 166               | 168 | 170        | 173 |
| 170    | 177         | 179 | 177               | 179 | 185        | 187 |
| 180    | 187         | 189 | 187               | 189 | 199        | 202 |
| 190    | 198         | 200 | 198               | 200 | 213        | 216 |
| 200    | 208         | 210 | 208               | 210 | 224        | 228 |
|        |             |     |                   |     | 284        | 288 |

<sup>†</sup>Effective MC 449, MC 452 thru MC 555

<sup>‡</sup>Effective MC 556 and after

\*Reclining seat with back in full "up" position

\*\*Values compiled from a CG criterion based on a 170 pound male. Differences in physical characteristics can cause variation in center of gravity location

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Section VI  
Wt & Bal/Equip List

BEECHCRAFT  
Sierra C24R

USEFUL LOAD WEIGHTS AND MOMENTS

| 5th & 6th SEATS<br>ARM 171 |               |        |               |
|----------------------------|---------------|--------|---------------|
| Weight                     | Moment<br>100 | Weight | Moment<br>100 |
| 80                         | 137           | 140    | 239           |
| 90                         | 154           | 150    | 257           |
| 100                        | 171           | 160    | 274           |
| 110                        | 188           | 170    | 291           |
| 120                        | 205           | 180    | 308           |
| 130                        | 222           | 190    | 325           |
|                            |               | 200    | 342           |

USABLE FUEL  
ARM 117

| GALLONS | WEIGHT | MOMENT/100 |
|---------|--------|------------|
| 5       | 30     | 35         |
| 10      | 60     | 70         |
| 15      | 90     | 105        |
| 20      | 120    | 140        |
| 22      | 132    | 154        |
| 25      | 150    | 176        |
| 27      | 162    | 189        |
| 30      | 180    | 211        |
| 32      | 192    | 225        |
| 35      | 210    | 246        |
| 37      | 222    | 259        |
| 40      | 240    | 281        |
| 45      | 270    | 316        |
| 50      | 300    | 351        |
| 52      | 312    | 365        |
| 57      | 342    | 400        |

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BEECHCRAFT  
Sierra C24R

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Wt & Bal/Equip List

USEFUL LOAD WEIGHTS AND MOMENTS

BAGGAGE

ARM 167

| Weight | Moment<br>100 | Weight | Moment<br>100 |
|--------|---------------|--------|---------------|
| 10     | 17            | 140    | 234           |
| 20     | 33            | 150    | 251           |
| 30     | 50            | 160    | 267           |
| 40     | 67            | 170    | 284           |
| 50     | 84            | 180    | 301           |
| 60     | 100           | 190    | 317           |
| 70     | 117           | 200    | 334           |
| 80     | 134           | 210    | 351           |
| 90     | 150           | 220    | 367           |
| 100    | 167           | 230    | 384           |
| 110    | 184           | 240    | 401           |
| 120    | 200           | 250    | 418           |
| 130    | 217           | 260    | 434           |
|        |               | 270    | 451           |

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SPECIFICATIONS  
AND  
WEIGHT AND BALANCE  
FOR THE BEECHCRAFT SUNDOWNER 180 C23

AERO 495

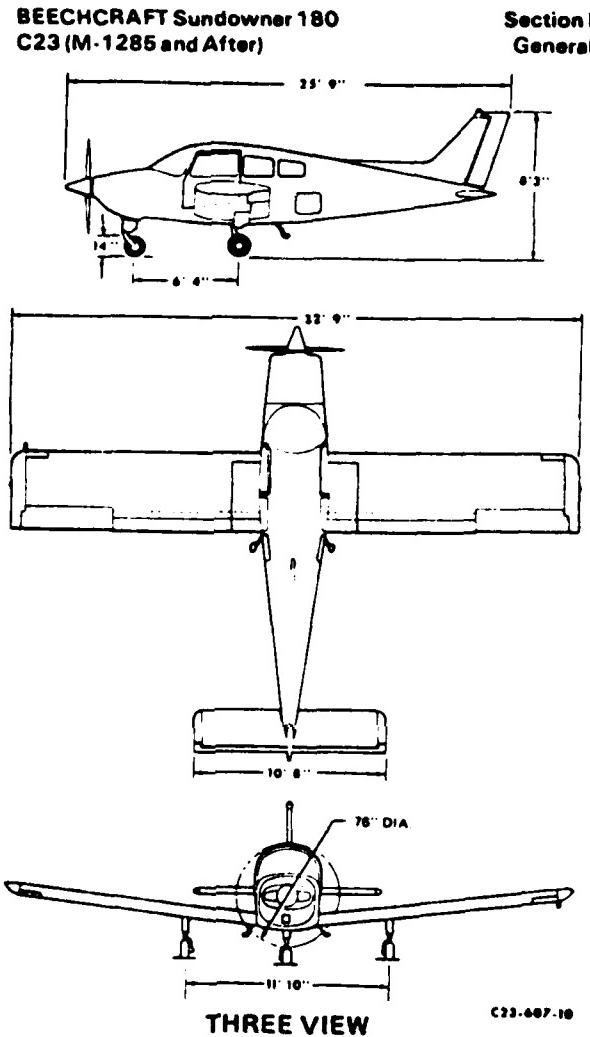
FALL 1982

A-30

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| II.  | GENERAL . . . . .            | 2           |
| III. | PERFORMANCE CHARTS . . . . . | 3           |
| IV.  | WEIGHT AND BALANCE . . . . . | 9           |

1. GEOMETRY

A. Three View



B. Wing

|                             |                     |
|-----------------------------|---------------------|
| Span, b                     | 32' 9"              |
| Mean Aerodynamic Chord, MAC | 52.7"               |
| Area, S                     | 146 ft <sup>2</sup> |
| Aspect Ratio, AR            | 7.5                 |
| Taper Ratio,                | 1.0                 |
| Dihedral                    | 6.0°                |

II. GENERAL

A. Engine, Avco Lycoming, 4 cylinder O-360-A

Maximum continuous power (at sea level) 180 HP @ 2,700 rpm

B. Propeller, two bladed, fixed pitch Sensenich, diameter 76"

Restricted Operation 2,150-2,350 rpm

C. Capacities

|                |                   |
|----------------|-------------------|
| Crew and Pilot | 4                 |
| Oil            | 8 quarts          |
| Fuel           | 59.8 gallons      |
|                | 52 gallons usable |

D. Design Load Factor

(2,450 pounds, flaps up) +3.8 to -1.9

E. Airspeeds

|  |                 |
|--|-----------------|
| Takeoff (flaps up)                         | 65 KTS/75 MPH   |
| Climb (best rate)                          | 75 KTS/86 MPH   |
| Climb (best angle)                         | 69 KTS/79 MPH   |
| Max Glide                                  | 78 KTS/90 MPH   |
| Emergency App.                             | 68 KTS/78 MPH   |
| Normal App. (flaps down)                   | 68 KTS/78 MPH   |
| Normal App. (flaps up)                     | 80 KTS/92 MPH   |
| 1G Stall Speed (flaps up, 2,450 lbs)       | 63 KTS/72 MPH   |
| Maximum permissible speed, V <sub>NE</sub> | 152 KTS/175 MPH |

Section V  
Performance

BEECHCRAFT Sundowner 180  
C23(M-1285 and After)

Section V  
Performance

BEECHCRAFT Sundowner 180  
C23(M-1285 and After)

III. Performance Charts

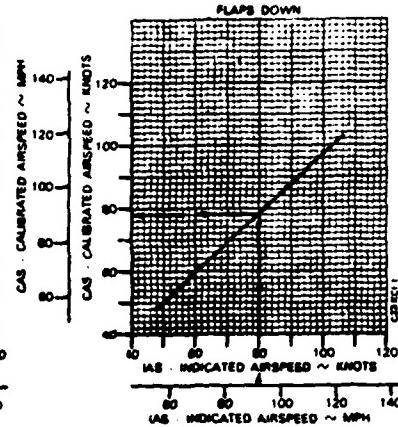
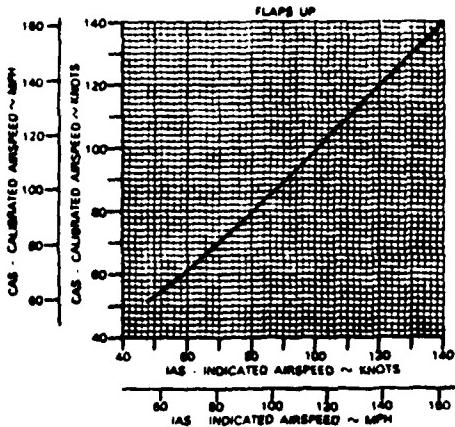
A. Pitot-Static Calibration Data

5-8

AIRSPEED CALIBRATION - NORMAL SYSTEM

NOTE PINDI  
INSTRUMENT

SPEED ASSUMES ZERO



EXAMPLE  
FLAPS  
UP  
DOWN  
80 IAS  
78 IAS

DOWN

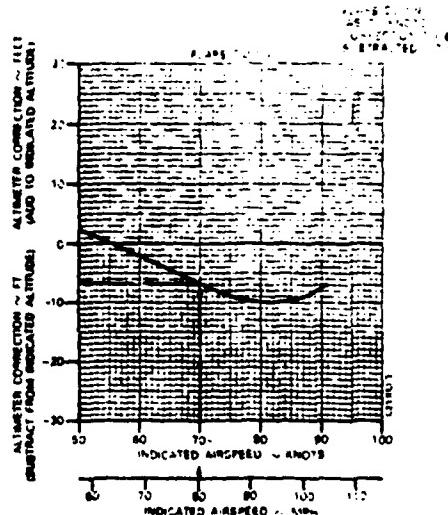
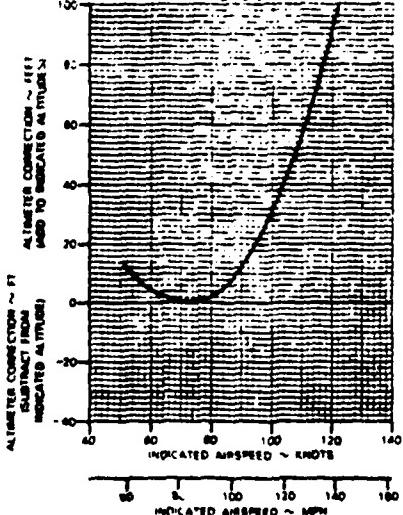
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ALTIMETER CORRECTION - NORMAL SYSTEM

NOTE PINDI  
INSTRUMENT  
NOTES ON INDICATED AIRSPEED  
INDICATED AIRSPEED  
IS NOT CORRECTED FOR ALTITUDE



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B. Power-Off Stall Speeds

Section V  
Performance

BEECHCRAFT Sundowner 180  
C23(M-1285 and After)

**POWER OFF STALL SPEEDS**

*(WEIGHT 2450 LBS.)*

*Maximum altitude loss during a normal stall recovery is approximately 300 ft.*

| ANGLE OF BANK             |                  |                  |                   |
|---------------------------|------------------|------------------|-------------------|
| LEVEL                     | 30°              | 45°              | 60°               |
| <b>FLAPS-UP</b>           |                  |                  |                   |
| 72 mph<br>63 kts          | 77 mph<br>67 kts | 85 mph<br>74 kts | 101 mph<br>88 kts |
| <b>FLAPS - DOWN (35°)</b> |                  |                  |                   |
| 59 mph<br>51 kts          | 63 mph<br>55 kts | 70 mph<br>61 kts | 83 mph<br>72 kts  |

C. Crosswind Chart

BEECHCRAFT Sundowner 180  
C23 (M-1285 and After)

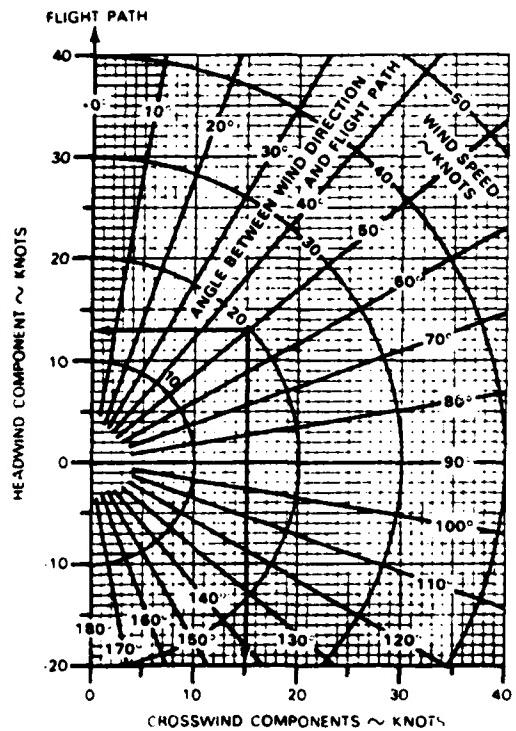
Section V  
Performance

**WIND COMPONENTS**

Demonstrated Crosswind Component is 17kts/20mph

EXAMPLE

| WIND SPEED<br>ANGLE BETWEEN WIND DIRECTION AND FLIGHT PATH | 20 KTS<br>50° |
|--|---------------|
| HEADWIND COMPONENT   | 13 KTS        |
| CROSSWIND COMPONENT  | 15 KTS        |



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Section V  
Performance

BEECHCRAFT Sundowner 180  
C23 (M-1285 and After)

BEECHCRAFT Sundowner 180  
C23 (M-1285 and After)

Section V  
Performance

D. Takeoff and Landing Data

5-14

TAKE-OFF DISTANCE - HARD SURFACE

| WIND<br>COMPONENT<br>DOWN<br>RUNWAY<br>KNOTS | ASSOCIATED CONDITIONS |                        |   |         |              |                        | TAKE-OFF SPEEDS                         |      |              |                        |   |      |
|--|-----------------------|------------------------|---|---------|--------------|------------------------|---|------|--------------|------------------------|---|------|
|  | SEA LEVEL             |                        |   | 2000 FT |              |                        | 4000 FT                                 |      |              | 6000 FT                |   |      |
|  | OAT<br>°F °C          | GROUND<br>ROLL<br>FEET | TOTAL<br>OVER 50 FT<br>OBSTACLE<br>FEET |         | OAT<br>°F °C | GROUND<br>ROLL<br>FEET | TOTAL<br>OVER 50 FT<br>OBSTACLE<br>FEET |      | OAT<br>°F °C | GROUND<br>ROLL<br>FEET | TOTAL<br>OVER 50 FT<br>OBSTACLE<br>FEET |      |
| 0  | 73 5                  | 917                    | 1592                                    | 10 0    | 1048         | 1805                   | 9 13                                    | 1196 | 20 1         | 1388                   | 2334                                    | 6 21 |
|  | 41 5                  | 1020                   | 1767                                    | 34 1    | 1165         | 2007                   | 27 3                                    | 1333 | 2204         | 20 7                   | 1528                                    | 2604 |
|  | 59 15                 | 1130                   | 1955                                    | 52 11   | 1293         | 2224                   | 45 7                                    | 1481 | 2525         | 38 3                   | 1701                                    | 2954 |
|  | 77 25                 | 1248                   | 2155                                    | 70 21   | 1429         | 2465                   | 63 17                                   | 1640 | 2802         | 56 13                  | 1866                                    | 3204 |
| 10   | 96 30                 | 1373                   | 2369                                    | 88 31   | 1575         | 2701                   | 81 27                                   | 1803 | 3087         | 74 23                  | 2083                                    | 3635 |
|  | 23 5                  | 729                    | 1484                                    | 10 0    | 838          | 1883                   | 9 13                                    | 881  | 1883         | 2 17                   | 1108                                    | 2149 |
|  | 41 5                  | 813                    | 1618                                    | 34 1    | 938          | 1842                   | 27 3                                    | 1077 | 2102         | 20 7                   | 1243                                    | 2402 |
|  | 59 15                 | 904                    | 1793                                    | 52 11   | 1042         | 2046                   | 46 7                                    | 1202 | 2338         | 38 3                   | 1389                                    | 2674 |
| 30   | 77 25                 | 1003                   | 1860                                    | 70 21   | 1158         | 2261                   | 63 17                                   | 1335 | 2687         | 66 13                  | 1546                                    | 2985 |
|  | 95 30                 | 1107                   | 2160                                    | 88 31   | 1279         | 2462                   | 81 27                                   | 1470 | 2886         | 74 23                  | 1714                                    | 3277 |
|  | 23 5                  | 860                    | 1337                                    | 10 0    | 647          | 1823                   | 9 13                                    | 751  | 1730         | 2 17                   | 873                                     | 1988 |
|  | 41 5                  | 828                    | 1490                                    | 34 1    | 728          | 1700                   | 27 3                                    | 847  | 1844         | 20 7                   | 986                                     | 2227 |
| 30   | 59 15                 | 702                    | 1664                                    | 52 11   | 818          | 1880                   | 45 7                                    | 949  | 2164         | 38 3                   | 1107                                    | 2483 |
|  | 77 25                 | 782                    | 1829                                    | 70 21   | 910          | 2094                   | 63 17                                   | 1080 | 2401         | 56 13                  | 1237                                    | 2756 |
|  | 95 30                 | 868                    | 2017                                    | 88 31   | 1011         | 2311                   | 81 27                                   | 1180 | 2863         | 74 23                  | 1378                                    | 3052 |

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LANDING DISTANCE - HARD SURFACE

| WIND<br>COMPONENT<br>DOWN<br>RUNWAY<br>KNOTS | ASSOCIATED CONDITIONS |                        |   |         |              |                        | LANDING SPEEDS                          |     |              |                        |   |      |
|--|-----------------------|------------------------|---|---------|--------------|------------------------|---|-----|--------------|------------------------|---|------|
|  | SEA LEVEL             |                        |   | 2000 FT |              |                        | 4000 FT                                 |     |              | 6000 FT                |   |      |
|  | OAT<br>°F °C          | GROUND<br>ROLL<br>FEET | TOTAL<br>OVER 50 FT<br>OBSTACLE<br>FEET |         | OAT<br>°F °C | GROUND<br>ROLL<br>FEET | TOTAL<br>OVER 50 FT<br>OBSTACLE<br>FEET |     | OAT<br>°F °C | GROUND<br>ROLL<br>FEET | TOTAL<br>OVER 50 FT<br>OBSTACLE<br>FEET |      |
| 0  | 73 5                  | 864                    | 1408                                    | 10 0    | 993          | 1467                   | 9 13                                    | 735 | 1532         | 2 17                   | 780                                     | 1820 |
|  | 41 5                  | 878                    | 1446                                    | 34 1    | 710          | 1500                   | 27 3                                    | 763 | 1576         | 70 7                   | 810                                     | 1844 |
|  | 59 10                 | 703                    | 1484                                    | 52 11   | 748          | 1540                   | 45 7                                    | 761 | 1617         | 28 3                   | 840                                     | 1991 |
|  | 77 25                 | 727                    | 1521                                    | 70 21   | 771          | 1587                   | 63 17                                   | 816 | 1656         | 56 13                  | 871                                     | 1740 |
| 10   | 95 30                 | 761                    | 1548                                    | 88 31   | 798          | 1626                   | 81 27                                   | 847 | 1703         | 74 23                  | 901                                     | 1788 |
|  | 23 5                  | 498                    | 1190                                    | 10 0    | 530          | 1243                   | 9 13                                    | 587 | 1302         | 2 17                   | 807                                     | 1365 |
|  | 41 5                  | 512                    | 1222                                    | 34 1    | 553          | 1280                   | 27 3                                    | 582 | 1342         | 70 7                   | 834                                     | 1407 |
|  | 59 15                 | 539                    | 1257                                    | 52 11   | 578          | 1317                   | 45 7                                    | 617 | 1381         | 38 3                   | 881                                     | 1448 |
| 30   | 77 25                 | 540                    | 1291                                    | 70 21   | 600          | 1354                   | 63 17                                   | 642 | 1420         | 56 13                  | 888                                     | 1489 |
|  | 95 30                 | 582                    | 1326                                    | 88 31   | 623          | 1380                   | 81 27                                   | 667 | 1458         | 74 23                  | 715                                     | 1530 |
|  | 23 5                  | 361                    | 1005                                    | 10 0    | 390          | 1049                   | 9 13                                    | 421 | 1095         | 2 17                   | 456                                     | 1149 |
|  | 41 5                  | 379                    | 1032                                    | 34 1    | 408          | 1078                   | 27 3                                    | 443 | 1127         | 70 7                   | 479                                     | 1189 |
| 30   | 59 15                 | 397                    | 1060                                    | 52 11   | 429          | 1107                   | 45 7                                    | 464 | 1163         | 38 3                   | 502                                     | 1226 |
|  | 77 25                 | 418                    | 1088                                    | 70 21   | 449          | 1138                   | 63 17                                   | 486 | 1200         | 56 13                  | 526                                     | 1264 |
|  | 95 30                 | 434                    | 1114                                    | 88 31   | 469          | 1172                   | 81 27                                   | 509 | 1235         | 74 23                  | 550                                     | 1303 |

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E. Climb Data

BEECHCRAFT Sundowner 180  
C23 (M-1285 and After)

Section V  
Performance

TIME, FUEL, AND DISTANCE TO CLIMB

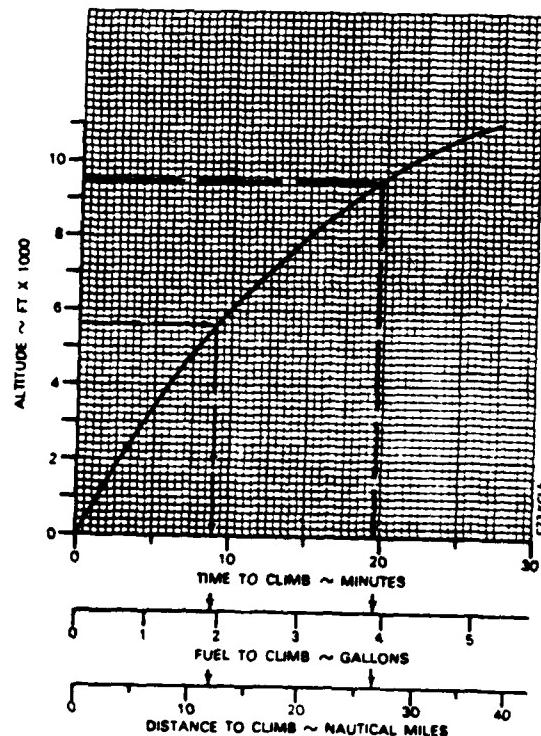
ASSOCIATED CONDITIONS

POWER FULL THROTTLE  
MIXTURE LEAN TO MAXIMUM RPM  
FLAPS UP  
WEIGHT 2480 LBS  
STANDARD DAY

EXAMPLE

APPROXIMATE ALTITUDE 5800 FT  
CRUISE ALTITUDE 5800 FT  
TIME TO CLIMB 20.0 MIN  
FUEL TO CLIMB 2.0 GAL  
DIST TO CLIMB 27.12 NM

70 KTS/80 MPH



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5-17

F. Cruise Data

Section V  
Performance

BEECHCRAFT Sundowner 180  
C23 (M-1285 and After)

CRUISE PERFORMANCE  
STANDARD DAY

| ALTITUDE<br>FEET | POWER SETTINGS       |     |                     | TAS<br>KTBS MPH | RANGE - N.M.                               |        |  |
|------------------|----------------------|-----|---------------------|-----------------|--|--------|--|
|                  | THROTTLE<br>SETTINGS |     | FUEL FLOW<br>GAL/HR |                 | INITIAL FUEL ONBOARD<br>(USABLE)<br>57 GAL | 57 GAL |  |
|                  | RPM                  | BHP |                     |                 |  |        |  |
| 2800             | 2700                 | 68  | 13.2                | 124/143         | 276  | 466    |  |
|                  | 2600                 | 73  | 10.4                | 113/130         | 318  | 536    |  |
|                  | 2300                 | 60  | 8.2                 | 100/118         | 386  | 606    |  |
| 3500             | 2700                 | 68  | 12.8                | 123/142         | 272  | 471    |  |
|                  | 2500                 | 71  | 10.1                | 112/128         | 319  | 561    |  |
|                  | 2300                 | 59  | 8.1                 | 98/113          | 384  | 612    |  |
| 4800             | 2700                 | 84  | 12.8                | 123/141         | 288  | 484    |  |
|                  | 2600                 | 70  | 9.8                 | 111/127         | 328  | 563    |  |
|                  | 2300                 | 59  | 8.0                 | 98/113          | 354  | 587    |  |
| 5800             | 2695                 | 82  | 12.0                | 122/140         | 295  | 498    |  |
|                  | 2500                 | 68  | 9.6                 | 110/127         | 333  | 562    |  |
|                  | 2300                 | 58  | 7.9                 | 97/112          | 386  | 600    |  |
| 6500             | 2688                 | 79  | 11.6                | 121/139         | 308  | 512    |  |
|                  | 2500                 | 67  | 9.4                 | 109/126         | 337  | 572    |  |
|                  | 2300                 | 58  | 7.9                 | 96/110          | 349  | 582    |  |
| 7800             | 2680                 | 77  | 11.2                | 120/138         | 308  | 521    |  |
|                  | 2500                 | 66  | 9.2                 | 108/128         | 340  | 576    |  |
|                  | 2300                 | 57  | 7.9                 | 96/109          | 346  | 587    |  |
| 8500             | 2670                 | 75  | 10.8                | 119/136         | 318  | 533    |  |
|                  | 2600                 | 65  | 9.0                 | 108/124         | 341  | 582    |  |
|                  | 2300                 | 57  | 7.8                 | 94/108          | 341  | 579    |  |
| 9500             | 2662                 | 73  | 10.8                | 117/136         | 318  | 542    |  |
|                  | 2600                 | 64  | 8.8                 | 107/123         | 308  | 588    |  |
|                  | 2300                 | 57  | 7.8                 | 93/108          | 334  | 571    |  |
| 10,500           | 2654                 | 71  | 10.2                | 116/133         | 326  | 546    |  |
|                  | 2500                 | 63  | 8.7                 | 106/122         | 340  | 582    |  |
|                  | 2300                 | 57  | 7.9                 | 91/104          | 325  | 566    |  |

- NOTES: 1. Range includes start, taxi, climb, and a 45 minute reserve at 2300 RPM.  
 2. Cruise performance is based on best power mixture. Lean to maximum RPM for a given throttle setting.  
 3. It is recommended that use of tanks be alternated and that a fuel log be maintained showing time remaining in tanks.  
 4. For a particular RPM the fuel flow and true airspeed will vary with temperature. To determine in flight fuel flow, enter the table at the nearest altitude corresponding to the density altitude, and the actual true airspeed.

ASSOCIATED CONDITIONS:

|                    |           |
|--------------------|-----------|
| Pressure Altitude  | 4600 feet |
| DAT                | 53°F      |
| Indicated Airspeed | 111 kts   |

EXAMPLE:

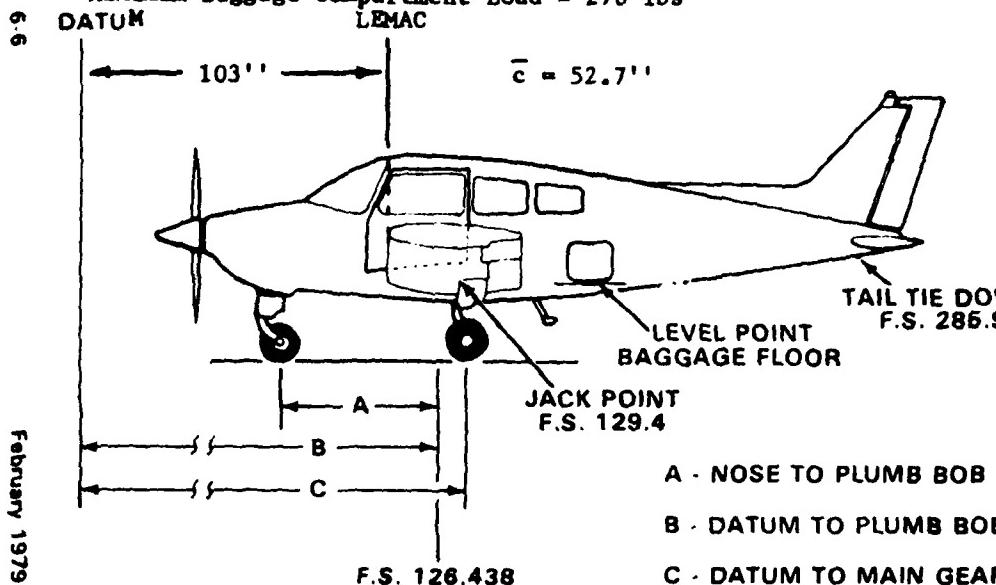
|   |             |
|---|-------------|
| Density Altitude  | 6200 feet   |
| Actual True Airspeed  | 121 kts     |
| Corresponding Altitude on Table   | 6800 feet   |
| Interpolating Factor (121 kts is 92% of the difference between 110 and 122 kts)   | 92%         |
| Fuel Flow ( $12.0 \times .92 = 2.4 \times .92$<br>$2.2 \times .92 = 11.8$ gal/hr) | 11.8 gal/hr |

Section VI  
Weight and Balance/Equip List

BEECHCRAFT Sundowner 180  
C23(M-1285 and After)

IV. Weight and Balance

Maximum Ramp Weight = 2455 lbs  
Maximum Take-off and Landing Weight = 2450 lbs  
Maximum Baggage Compartment Load = 270 lbs



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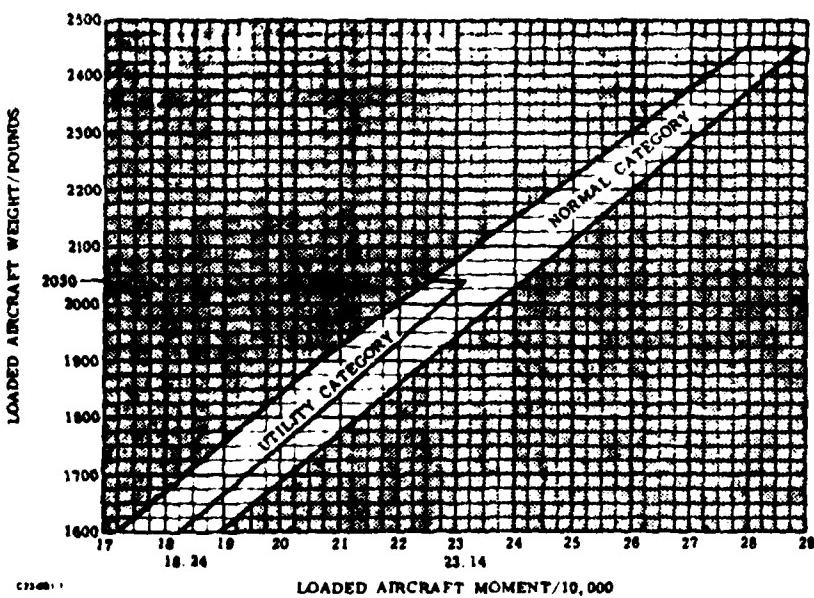
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Section VI  
Weight and Balance/Equip List

BEECHCRAFT Sundowner 180  
C23(M-1285 and After)

GROSS WEIGHT MOMENT LIMITS GRAPH



BEECHCRAFT Sundowner 180      Section VI  
C23(M-1285 and After)      Wt and Bal/Equip List

**COMPUTING PROCEDURE**

- Record the Basic Empty Weight and Moment from the Basic Empty Weight and Balance form (or from the latest superseding form) under the Basic Empty Condition block. The moment must be divided by 100 to correspond to Useful Load Weights and Moments tables.
- Record the weight and corresponding moment from the appropriate table of each of the useful load items (except fuel) to be carried in the airplane.
- Total the weight column and moment column. The SUB-TOTAL is the Zero Fuel Condition.
- Determine the weight and corresponding moment for the fuel loading to be used. This fuel loading includes fuel for the flight, plus that required for start, taxi, and take-off. Add the Fuel to Zero Fuel Condition to obtain the SUB-TOTAL Ramp Condition.
- Subtract the fuel to be used for start, taxi, and take-off to arrive at the SUB-TOTAL Take-off Condition.
- Subtract the weight and moment of the fuel in the incremental sequence in which it is to be used from the take-off weight and moment. The Zero Fuel Condition, the Take-Off Condition, and the Landing Condition moment must be within the minimum and maximum moments shown on the Moment Limit vs Weight graph for that weight. If the total moment is less than the minimum moment allowed, useful load items must be shifted aft or forward load items reduced. If the total moment is greater than the maximum moment allowed, useful load items must be shifted forward or aft until items reduced. If the quantity or location of load items is changed, the calculations must be revised and the moments rechecked.

BEECHCRAFT Sundowner 180      Section VI  
C23(M-1285 and After)      Wt and Bal/Equip List

**GROSS WEIGHT MOMENT LIMITS**

| NORMAL CATEGORY VI |          | GROSS WEIGHT MOMENT LIMITS |                   |                      |                   |                   |                      |                   |                   |                      |                   |                   |                      |
|--------------------|----------|----------------------------|-------------------|----------------------|-------------------|-------------------|----------------------|-------------------|-------------------|----------------------|-------------------|-------------------|----------------------|
| Condition          | Category | Minimum<br>Weight          | Maximum<br>Weight | Center<br>of Gravity | Minimum<br>Moment | Maximum<br>Moment | Center<br>of Gravity | Minimum<br>Weight | Maximum<br>Weight | Center<br>of Gravity | Minimum<br>Moment | Maximum<br>Moment | Center<br>of Gravity |
| 1000               | 1000     | 1173                       | 1800              | 2000                 | 2700              | 2800              | 2900                 | 2700              | 2800              | 2900                 | 2700              | 2800              | 2900                 |
| 1100               | 1100     | 1196                       | 1910              | 2000                 | 2801              | 2860              | 2911                 | 2800              | 2850              | 2913                 | 2800              | 2850              | 2913                 |
| 1200               | 1200     | 1208                       | 1920              | 2000                 | 2802              | 2862              | 2912                 | 2802              | 2852              | 2914                 | 2802              | 2852              | 2914                 |
| 1300               | 1300     | 1222                       | 1940              | 2000                 | 2803              | 2863              | 2913                 | 2803              | 2853              | 2915                 | 2803              | 2853              | 2915                 |
| 1400               | 1400     | 1237                       | 1955              | 2000                 | 2804              | 2864              | 2914                 | 2804              | 2854              | 2916                 | 2804              | 2854              | 2916                 |
| 1500               | 1500     | 1252                       | 1968              | 2000                 | 2805              | 2865              | 2915                 | 2805              | 2855              | 2917                 | 2805              | 2855              | 2917                 |
| 1600               | 1600     | 1267                       | 1982              | 2000                 | 2806              | 2866              | 2916                 | 2806              | 2856              | 2918                 | 2806              | 2856              | 2918                 |
| 1700               | 1700     | 1282                       | 1995              | 2000                 | 2807              | 2867              | 2917                 | 2807              | 2857              | 2919                 | 2807              | 2857              | 2919                 |
| 1800               | 1800     | 1296                       | 2008              | 2000                 | 2808              | 2868              | 2918                 | 2808              | 2858              | 2920                 | 2808              | 2858              | 2920                 |
| 1900               | 1900     | 1311                       | 2021              | 2000                 | 2809              | 2869              | 2919                 | 2809              | 2859              | 2921                 | 2809              | 2859              | 2921                 |
| 2000               | 2000     | 1325                       | 2035              | 2000                 | 2810              | 2870              | 2920                 | 2810              | 2860              | 2922                 | 2810              | 2860              | 2922                 |
| 2100               | 2100     | 1340                       | 2048              | 2000                 | 2811              | 2871              | 2921                 | 2811              | 2861              | 2923                 | 2811              | 2861              | 2923                 |
| 2200               | 2200     | 1353                       | 2062              | 2000                 | 2812              | 2872              | 2922                 | 2812              | 2862              | 2924                 | 2812              | 2862              | 2924                 |
| 2300               | 2300     | 1367                       | 2075              | 2000                 | 2813              | 2873              | 2923                 | 2813              | 2863              | 2925                 | 2813              | 2863              | 2925                 |
| 2400               | 2400     | 1382                       | 2088              | 2000                 | 2814              | 2874              | 2924                 | 2814              | 2864              | 2926                 | 2814              | 2864              | 2926                 |
| 2500               | 2500     | 1396                       | 2101              | 2000                 | 2815              | 2875              | 2925                 | 2815              | 2865              | 2927                 | 2815              | 2865              | 2927                 |
| 2600               | 2600     | 1410                       | 2114              | 2000                 | 2816              | 2876              | 2926                 | 2816              | 2866              | 2928                 | 2816              | 2866              | 2928                 |
| 2700               | 2700     | 1424                       | 2127              | 2000                 | 2817              | 2877              | 2927                 | 2817              | 2867              | 2929                 | 2817              | 2867              | 2929                 |
| 2800               | 2800     | 1438                       | 2140              | 2000                 | 2818              | 2878              | 2928                 | 2818              | 2868              | 2930                 | 2818              | 2868              | 2930                 |
| 2900               | 2900     | 1452                       | 2153              | 2000                 | 2819              | 2879              | 2929                 | 2819              | 2869              | 2931                 | 2819              | 2869              | 2931                 |
| 3000               | 3000     | 1466                       | 2166              | 2000                 | 2820              | 2880              | 2930                 | 2820              | 2870              | 2932                 | 2820              | 2870              | 2932                 |
| 3100               | 3100     | 1480                       | 2179              | 2000                 | 2821              | 2881              | 2931                 | 2821              | 2871              | 2933                 | 2821              | 2871              | 2933                 |
| 3200               | 3200     | 1494                       | 2192              | 2000                 | 2822              | 2882              | 2932                 | 2822              | 2872              | 2934                 | 2822              | 2872              | 2934                 |
| 3300               | 3300     | 1508                       | 2205              | 2000                 | 2823              | 2883              | 2933                 | 2823              | 2873              | 2935                 | 2823              | 2873              | 2935                 |
| 3400               | 3400     | 1522                       | 2218              | 2000                 | 2824              | 2884              | 2934                 | 2824              | 2874              | 2936                 | 2824              | 2874              | 2936                 |
| 3500               | 3500     | 1536                       | 2231              | 2000                 | 2825              | 2885              | 2935                 | 2825              | 2875              | 2937                 | 2825              | 2875              | 2937                 |
| 3600               | 3600     | 1550                       | 2244              | 2000                 | 2826              | 2886              | 2936                 | 2826              | 2876              | 2938                 | 2826              | 2876              | 2938                 |
| 3700               | 3700     | 1564                       | 2257              | 2000                 | 2827              | 2887              | 2937                 | 2827              | 2877              | 2939                 | 2827              | 2877              | 2939                 |
| 3800               | 3800     | 1578                       | 2270              | 2000                 | 2828              | 2888              | 2938                 | 2828              | 2878              | 2940                 | 2828              | 2878              | 2940                 |
| 3900               | 3900     | 1592                       | 2283              | 2000                 | 2829              | 2889              | 2939                 | 2829              | 2879              | 2941                 | 2829              | 2879              | 2941                 |
| 4000               | 4000     | 1606                       | 2296              | 2000                 | 2830              | 2890              | 2940                 | 2830              | 2880              | 2942                 | 2830              | 2880              | 2942                 |
| 4100               | 4100     | 1620                       | 2309              | 2000                 | 2831              | 2891              | 2941                 | 2831              | 2881              | 2943                 | 2831              | 2881              | 2943                 |
| 4200               | 4200     | 1634                       | 2322              | 2000                 | 2832              | 2892              | 2942                 | 2832              | 2882              | 2944                 | 2832              | 2882              | 2944                 |
| 4300               | 4300     | 1648                       | 2335              | 2000                 | 2833              | 2893              | 2943                 | 2833              | 2883              | 2945                 | 2833              | 2883              | 2945                 |
| 4400               | 4400     | 1662                       | 2348              | 2000                 | 2834              | 2894              | 2944                 | 2834              | 2884              | 2946                 | 2834              | 2884              | 2946                 |
| 4500               | 4500     | 1676                       | 2361              | 2000                 | 2835              | 2895              | 2945                 | 2835              | 2885              | 2947                 | 2835              | 2885              | 2947                 |
| 4600               | 4600     | 1690                       | 2374              | 2000                 | 2836              | 2896              | 2946                 | 2836              | 2886              | 2948                 | 2836              | 2886              | 2948                 |
| 4700               | 4700     | 1704                       | 2387              | 2000                 | 2837              | 2897              | 2947                 | 2837              | 2887              | 2949                 | 2837              | 2887              | 2949                 |
| 4800               | 4800     | 1718                       | 2400              | 2000                 | 2838              | 2898              | 2948                 | 2838              | 2888              | 2950                 | 2838              | 2888              | 2950                 |
| 4900               | 4900     | 1732                       | 2413              | 2000                 | 2839              | 2899              | 2949                 | 2839              | 2889              | 2951                 | 2839              | 2889              | 2951                 |
| 5000               | 5000     | 1746                       | 2426              | 2000                 | 2840              | 2900              | 2950                 | 2840              | 2890              | 2952                 | 2840              | 2890              | 2952                 |
| 5100               | 5100     | 1760                       | 2439              | 2000                 | 2841              | 2901              | 2951                 | 2841              | 2891              | 2953                 | 2841              | 2891              | 2953                 |
| 5200               | 5200     | 1774                       | 2452              | 2000                 | 2842              | 2902              | 2952                 | 2842              | 2892              | 2954                 | 2842              | 2892              | 2954                 |
| 5300               | 5300     | 1788                       | 2465              | 2000                 | 2843              | 2903              | 2953                 | 2843              | 2893              | 2955                 | 2843              | 2893              | 2955                 |
| 5400               | 5400     | 1802                       | 2478              | 2000                 | 2844              | 2904              | 2954                 | 2844              | 2894              | 2956                 | 2844              | 2894              | 2956                 |
| 5500               | 5500     | 1816                       | 2491              | 2000                 | 2845              | 2905              | 2955                 | 2845              | 2895              | 2957                 | 2845              | 2895              | 2957                 |
| 5600               | 5600     | 1830                       | 2504              | 2000                 | 2846              | 2906              | 2956                 | 2846              | 2896              | 2958                 | 2846              | 2896              | 2958                 |
| 5700               | 5700     | 1844                       | 2517              | 2000                 | 2847              | 2907              | 2957                 | 2847              | 2897              | 2959                 | 2847              | 2897              | 2959                 |
| 5800               | 5800     | 1858                       | 2530              | 2000                 | 2848              | 2908              | 2958                 | 2848              | 2898              | 2960                 | 2848              | 2898              | 2960                 |
| 5900               | 5900     | 1872                       | 2543              | 2000                 | 2849              | 2909              | 2959                 | 2849              | 2899              | 2961                 | 2849              | 2899              | 2961                 |
| 6000               | 6000     | 1886                       | 2556              | 2000                 | 2850              | 2910              | 2960                 | 2850              | 2900              | 2962                 | 2850              | 2900              | 2962                 |
| 6100               | 6100     | 1900                       | 2569              | 2000                 | 2851              | 2911              | 2961                 | 2851              | 2901              | 2963                 | 2851              | 2901              | 2963                 |
| 6200               | 6200     | 1914                       | 2582              | 2000                 | 2852              | 2912              | 2962                 | 2852              | 2902              | 2964                 | 2852              | 2902              | 2964                 |
| 6300               | 6300     | 1928                       | 2595              | 2000                 | 2853              | 2913              | 2963                 | 2853              | 2903              | 2965                 | 2853              | 2903              | 2965                 |
| 6400               | 6400     | 1942                       | 2608              | 2000                 | 2854              | 2914              | 2964                 | 2854              | 2904              | 2966                 | 2854              | 2904              | 2966                 |
| 6500               | 6500     | 1956                       | 2621              | 2000                 | 2855              | 2915              | 2965                 | 2855              | 2905              | 2967                 | 2855              | 2905              | 2967                 |
| 6600               | 6600     | 1970                       | 2634              | 2000                 | 2856              | 2916              | 2966                 | 2856              | 2906              | 2968                 | 2856              | 2906              | 2968                 |
| 6700               | 6700     | 1984                       | 2647              | 2000                 | 2857              | 2917              | 2967                 | 2857              | 2907              | 2969                 | 2857              | 2907              | 2969                 |
| 6800               | 6800     | 2000                       | 2660              | 2000                 | 2858              | 2918              | 2968                 | 2858              | 2908              | 2970                 | 2858              | 2908              | 2970                 |
| 6900               | 6900     | 2014                       | 2673              | 2000                 | 2859              | 2919              | 2969                 | 2859              | 2909              | 2971                 | 2859              | 2909              | 2971                 |
| 7000               | 7000     | 2028                       | 2686              | 2000                 | 2860              | 2920              | 2970                 | 2860              | 2910              | 2972                 | 2860              | 2910              | 2972                 |
| 7100               | 7100     | 2042                       | 2700              | 2000                 | 2861              | 2921              | 2971                 | 2861              | 2911              | 2973                 | 2861              | 2911              | 2973                 |
| 7200               | 7200     | 2056                       | 2713              | 2000                 | 2862              | 2922              | 2972                 | 2862              | 2912              | 2974                 | 2862              | 2912              | 2974                 |
| 7300               | 7300     | 2070                       | 2726              | 2000                 | 2863              | 2923              | 2973                 | 2863              | 2913              | 2975                 | 2863              | 2913              | 2975                 |
| 7400               | 7400     | 2084                       | 2739              | 2000                 | 2864              | 2924              | 2974                 | 2864              | 2914              | 2976                 | 2864              | 2914              | 2976                 |
| 7500               | 7500     | 2100                       | 2752              | 2000                 | 2865              | 2925              | 2975                 | 2865              | 2915              | 2977                 | 2865              | 2915              | 2977                 |
| 7600               | 7600     | 2114                       | 2765              | 2000                 | 2866              | 2926              | 2976                 | 2866              | 2916              | 2978                 | 2866              | 2916              | 2978                 |
| 7700               | 7700     | 2128                       | 2778              | 2000                 | 2867              | 2927              | 2977                 | 2867              | 2917              | 2979                 | 2867              | 2917              | 2979                 |
| 7800               | 7800     | 2142                       | 2791              | 2000                 | 2868              | 2928              | 2978                 | 2868              | 2918              | 2980                 | 2868              | 2918              | 2980                 |
| 7900               | 7900     | 2156                       | 2804              | 2000                 | 2869              | 2929              | 2979                 | 2869              | 2919              | 2981                 | 2869              | 2919              | 2981                 |
| 8000               | 8000     | 2170                       | 2817              | 2000                 | 2870              | 2930              | 2980                 | 2870              | 2920              | 2982                 | 2870              | 2920              | 2982                 |
| 8100               | 8100     | 2184                       | 2830              | 2000                 | 2871              | 2931              | 2981                 | 2871              | 2921              | 2983                 | 2871              | 2921              | 2983                 |
| 8200               | 8200     | 2200                       | 2843              | 2000                 | 2872              | 2932              | 2982                 | 2872              | 2922              | 2984                 | 2872              | 2922              | 2984                 |
| 8300               | 8300     | 2214                       | 2856              | 2000                 | 2873              | 2933              | 2983                 | 2873              | 2923              | 2985                 | 2873              | 2923              | 2985                 |
| 8400               | 8400     | 2228                       | 2869              | 2000                 | 2874              | 2934              | 2984                 | 2874              | 2924              | 2986                 | 2874              | 2924              | 2986                 |
| 8500               | 8500     | 2242                       | 2882              | 2000                 | 2875              | 2935              | 2985                 | 2875              | 2925              | 2987                 | 2875              | 2925              | 2987                 |
| 8600               | 8600     | 2256                       | 2895              | 2000                 | 2                 |                   |                      |                   |                   |                      |                   |                   |                      |

BEECHCRAFT Sundowner 180      Section VI  
C23(M-1285 and After)      Wt and Bal/Equip List

WEIGHT AND BALANCE LOADING FORM

MODEL \_\_\_\_\_ DATE \_\_\_\_\_

SERIAL NO. \_\_\_\_\_ REG NO. NXXX

| ITEM   | WEIGHT | MOM/100 |
|--|--------|---------|
| 1. BASIC EMPTY CONDITION                       |        |         |
| 2. FRONT SEAT OCCUPANTS                        |        |         |
| 3. 3rd & 4th SEAT OCCUPANTS                    |        |         |
| 4. BAGGAGE OR CARGO                            |        |         |
| 5. SUB TOTAL<br>ZERO FUEL CONDITION            |        |         |
| 6. FUEL LOADING ( GAL)                         |        |         |
| 7. SUB TOTAL<br>RAMP CONDITION                 |        |         |
| 8. *LESS FUEL FOR START,<br>TAXI, AND TAKE-OFF |        |         |
| 9. SUB TOTAL<br>TAKE-OFF CONDITION             |        |         |
| 10. LESS FUEL TO<br>DESTINATION ( GAL)         |        |         |
| 11. LANDING CONDITION                          |        |         |

\*Fuel for start, taxi and take-off is normally 5 lbs at an average  
mom/100 or 6.

| REG NO. | BASIC EMPTY<br>CONDITION | MOM/100 |
|---------|--------------------------|---------|
| N6014M  | 1590.0 lbs               | 1778    |
| N60171  | 1525.0 lbs               | 1688    |
| N18325  | 1580.5 lbs               | 1792    |

The following Sample Loading chart is presented to depict the sample method of computing a load. Weights used DO NOT reflect an actual airplane loading.

WEIGHT AND BALANCE LOADING FORM

MODEL \_\_\_\_\_ C23 DATE \_\_\_\_\_  
SERIAL NO. M-XXXX REG NO. NXXX

| ITEM                                     | WEIGHT | MOM/100 |
|--|--------|---------|
| 1. BASIC EMPTY CONDITION                 | 1500   | 1650    |
| 2. FRONT SEAT OCCUPANTS                  | 340    | 374     |
| 3. 3rd & 4th SEAT OCCUPANTS              | 340    | 482     |
| 4. BAGGAGE OR CARGO                      | 40     | 67      |
| 5. SUB TOTAL<br>ZERO FUEL CONDITION      | 2220   | 2573    |
| 6. FUEL LOADING (37 GAL)                 | 222    | 259     |
| 7. SUB TOTAL<br>RAMP CONDITION           | 2442   | 2832    |
| 8. *LESS FUEL<br>TAXI, AND TAKE-OFF      | -5     | -6      |
| 9. SUB TOTAL<br>TAKE-OFF CONDITION       | 2437   | 2826    |
| 10. LESS FUEL TO<br>DESTINATION (25 GAL) | -150   | -176    |
| 11. LANDING CONDITION                    | 2287   | 2650    |

\*Fuel for start, taxi and take-off is normally 5 lbs at an average  
mom/100 or 6.

Section VI  
Wt and Bal/Equip List  
BEECHCRAFT Sundowner 180  
C23(M-1285 and After)

USEFUL LOAD WEIGHTS AND MOMENTS

OCCUPANTS

| WEIGHT | FRONT SEATS    |               |              | 3RD AND 4TH SEATS |              |
|--------|----------------|---------------|--------------|-------------------|--------------|
|        | 'FWD POS.      |               | 'AFT POS.    | BENCH SEAT        | SPLIT SEAT   |
|        | ††ARM<br>**104 | †ARM<br>**105 | ARM<br>**112 | ARM<br>**142      | ARM<br>**144 |
|        | MOM<br>100     | MOM<br>100    | MOM<br>100   | MOM<br>100        | MOM<br>100   |
|        | 120            | 125           | 126          | 134               | 170          |
| 130    | 135            | 137           | 146          | 185               | 187          |
| 140    | 146            | 147           | 157          | 199               | 202          |
| 150    | 158            | 158           | 168          | 213               | 216          |
| 160    | 166            | 168           | 179          | 227               | 230          |
| 170    | 177            | 179           | 190          | 241               | 245          |
| 180    | 187            | 189           | 202          | 256               | 259          |
| 190    | 198            | 200           | 213          | 270               | 274          |
| 200    | 208            | 210           | 224          | 284               | 288          |

†Effective M-1285 thru M-2006

††Effective M-2007 and after

\*Reclining seat with back in full-up position

\*\*Values computed from a C G. criterion based on a 170 pound male. Differences in physical characteristics can cause variation in center of gravity location.

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BEECHCRAFT Sundowner 180  
C23 (M-1285 and After)

Section VI  
Wt and Bal/Equip List

**USEFUL LOAD WEIGHTS AND MOMENTS**

**OIL**  
(Included in Basic Empty Weight)

| ARM 48 |    |            |
|--------|----|------------|
| QTS    | WT | MOMENT/100 |
| 8      | 15 | 7          |

**USABLE FUEL**

| ARM 117 |        |            |
|---------|--------|------------|
| GALLONS | WEIGHT | MOMENT/100 |
| 5       | 30     | 35         |
| 10      | 60     | 70         |
| 15      | 90     | 105        |
| 20      | 120    | 140        |
| 22      | 132    | 154        |
| 25      | 150    | 176        |
| 27      | 162    | 189        |
| 30      | 180    | 211        |
| 32      | 192    | 225        |
| 35      | 210    | 246        |
| 37      | 222    | 259        |
| 40      | 240    | 281        |
| 45      | 270    | 316        |
| 50      | 300    | 351        |
| 52      | 312    | 365        |
| 55      | 330    | 386        |
| 57      | 342    | 400        |
| 58      | 348    | 407        |

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Section VI                    BEECHCRAFT Sundowner 180  
Wt and Bal/Equip List        C23 (M-1285 and After)

USEFUL LOAD WEIGHTS AND MOMENTS

BAGGAGE

| ARM 167 |               |
|---------|---------------|
| WEIGHT  | MOMENT<br>100 |
| 10      | 17            |
| 20      | 33            |
| 30      | 50            |
| 40      | 67            |
| 50      | 84            |
| 60      | 100           |
| 70      | 117           |
| 80      | 134           |
| 90      | 150           |
| 100     | 167           |
| 110     | 184           |
| 120     | 200           |
| 130     | 217           |
| 140     | 234           |

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## **APPENDIX B**

### **Test Plan Sierra C24R Limited Performance Evaluation**

UNITED STATES AIR FORCE ACADEMY

COLORADO 80840

DEPARTMENT OF AERONAUTICS

AERO 495

TEST PLAN

SIERRA C24R LIMITED PERFORMANCE EVALUATION

JUNE 1982

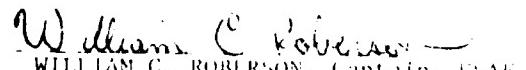
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TEST PLAN  
DEPARTMENT OF AERONAUTICS  
SIERRA C24R LIMITED PERFORMANCE EVALUATION  
JUNE 1982

This test plan has been prepared by:

  
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TEST PLAN  
DEPARTMENT OF AERONAUTICS  
SIERRA C24R LIMITED PERFORMANCE EVALUATION

INTRODUCTION

A Limited performance evaluation of the Beech Sierra C24R will be conducted at the U. S. Air Force Academy by Department of Aeronautics (DFAN) faculty members and the students enrolled in Aero 495. Flight testing will be conducted during the spring semester from the fifth to tenth week of classes. Results of the evaluation will be presented in a formal oral report given by each of two flight test teams.

OBJECTIVES

The objectives of this evaluation are to determine the Sierra C24R's general performance characteristics and to compare them to the contractor's Flight Manual. In addition, certain contractual guarantees are verified. Specific objectives follow.

A. Takeoff Performance

- determine takeoff power ground roll using the Flight Manual takeoff procedure
- verify the takeoff performance predicted in the contractor's Flight Manual

B. Climb Performance

- determine the full throttle maximum rate of climb
- determine the full throttle best angle of climb
- verify the climb performance predicted in the contractor's Flight Manual

C. Level Turn Performance

- determine the level sustained turn performance in cruise power at 1,700 rpm
- determine the speed for optimum sustained turn performance at the test altitude

D. Cruise Performance

- determine the airspeeds and rpm for maximum range and maximum endurance as derived from test data
- determine the aircraft drag polar
- compare test results with the contractor's Flight Manual

E. Descent Performance

- determine the propeller windmilling best no wind glide ratio
- determine the best glide speed and minimum sink speed with propeller windmilling
- compare test results with the contractor's Flight Manual maximum glide configuration of 91 knots

F. Contractual Guarantees

- maximum speed at sea level-142 knots
- cruise speed at 75% power, 10,000 feet-137 knots
- range with 45 minute reserve at 75% power at 10,000 feet-640 nautical miles
- rate of climb at sea level-927 fpm
- service ceiling-15,385 feet

AUTHORITY

This test program will be conducted by Department of Aeronautics faculty and students as an integral part of the curriculum for Aero 495, a course in flight test techniques. The program has the approval of the Superintendent, the Dean of the faculty, the Head of the Department of Aeronautics, and the Director of Flight Operation of Hedrick Beechcraft Inc.

TEST TEAM ORGANIZATION

Test team organization shown in Figure 1 will consist of two DFAN faculty pilots and two student flight test engineer teams. Each test team will be assigned to fly with one faculty pilot. A Test Director for each team will be appointed to coordinate the entire evaluation effort. He will in turn appoint individuals to be in charge of each test area (i.e., data monitors). It will be the data monitor's responsibility to specify the tests to be flown in support of his test area. Test areas to be assigned are takeoff, climb, turn, cruise and descent performance.

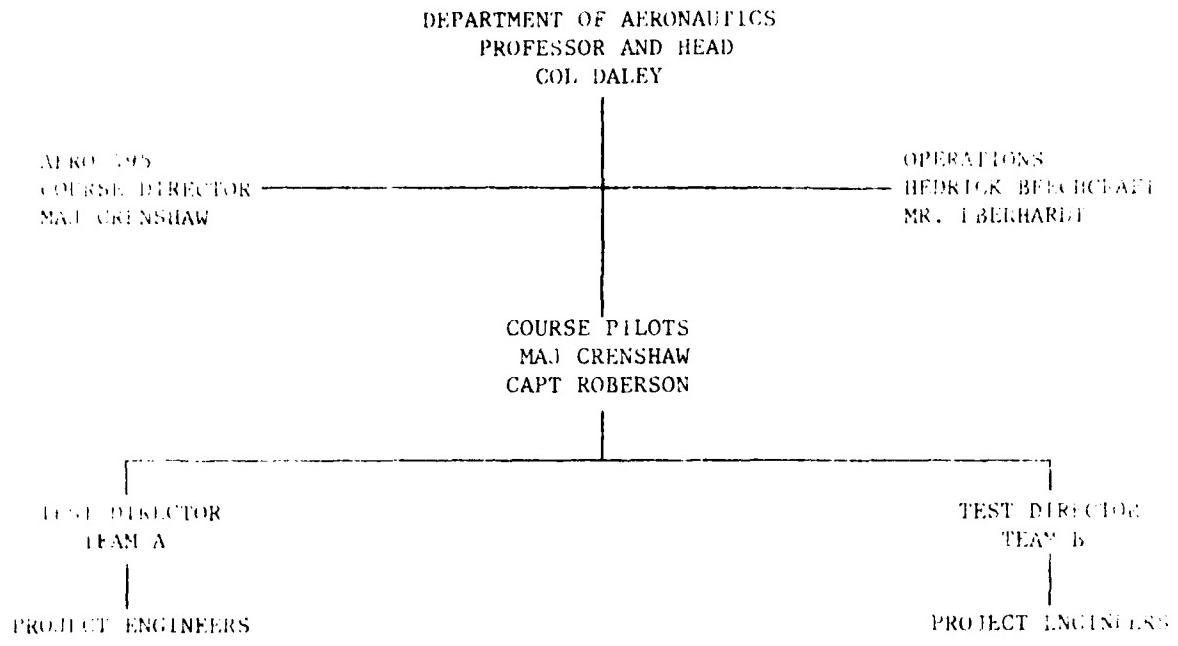


Figure 1. Organization Chart

## SCOPE/SCHEDULE

The evaluation will consist of sorties as specified in Table 1.

Table 1. Data Sorties

| Test   | Sorties<br>Per Test Team | Flight Time<br>Per Sortie |
|--|--------------------------|---------------------------|
| • Flight #1<br>Takeoff Performance<br>Cruise Performance<br>Turn Performance | 2.5                      | 1.0                       |
| • Flight #2<br>Takeoff Performance<br>Climbs and Descents                    | 2.5                      | 1.0                       |
| *Total   | 5                        |                           |

\*One sortie will be shared by both test teams.

Flight #1 and #2 are scheduled as shown on the Integrated Academics and Flying Schedule for Aero 495. Mission time will not exceed 1.0 hour.

## LIMITATIONS

The following limitations will be observed during this evaluation.

- A. The aircraft will be operated in accordance with the Airplane Flight Manual, FAR Part 91 and all Beech Aero Club Operating Instructions.
- B. All data sorties will be flown with one DFAN faculty pilot and two students.
- C. Testing will only be accomplished under VFR daytime conditions at 10,000 ft MSL and below.
- D. All testing will be accomplished within the local flying area of Colorado Springs.

## TEST AIRCRAFT DESCRIPTION

The Beechcraft Sierra C24R, manufactured by Beech Aircraft Corporation, is a six-place, retractable, general aviation aircraft powered by one fuel-injected, 4-cylinder, 200 HP Avco Lycoming engine. The propeller is a Hartzell constant-speed, two-blade, aluminum-alloy prop with spinner. See Figure 2 for general dimensions and Table 2 for Aircraft Limitations.

**BEECHCRAFT**  
**Sierra C24R**

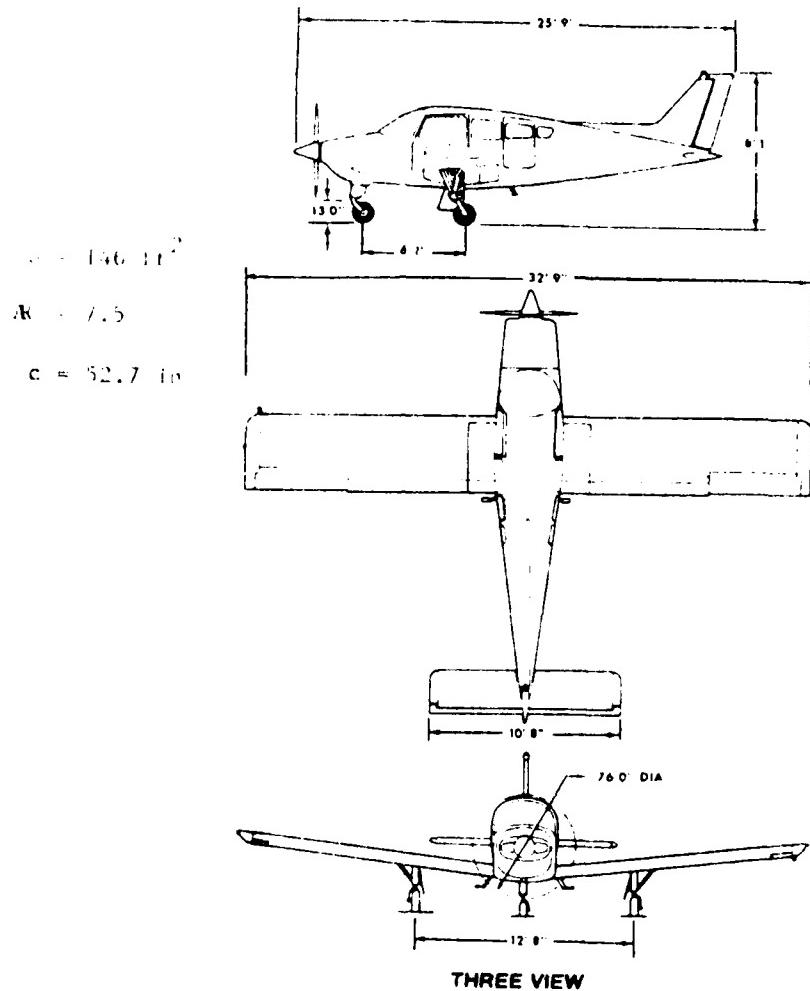


Figure 2. Three View of Sierra C24R  
(Reference 1)

Table 2. Aircraft Limitations

|  | IAS<br>Knots/mph |
|--|------------------|
| Never Exceed Speed ( $V_{NE}$ )                              | 168/193          |
| Maximum Maneuvering Speed ( $V_A$ )                          | 125/144          |
| Maximum Cruising Speed in Turbulent Air ( $V_c$ )            | 133/165          |
| IG Stall Speed Gear and Flaps Up (2,600 lbs)<br>(power idle) | 65/75            |
| Maximum Ramp Weight  | 2,785 lbs        |
| Maximum Takeoff Weight                                       | 2,750 lbs        |
| Maximum Landing Weight                                       | 2,750 lbs        |
| Flight Maneuvering Load Factor Flaps Up                      | +3.8 to -1.9G    |
| Flight Maneuvering Load Factor Flaps Down                    | +1.9G            |
| Maneuver, Bank Angles No More Than 60°                       |                  |
| Service Ceiling  | 15,385 feet      |
| Test Plan Ceiling  | 10,000 feet      |

**FLIGHT TEST INSTRUMENTATION**

All test data will be hand recorded using standard cockpit instrumentation. The only exceptions are the use of an accelerometer, a stopwatch and a cassette tape recorder.

**WEIGHT AND BALANCE**

Detailed weight and balance records for each aircraft are available at both the Beechcraft. Prior to every data mission, student test engineers will evaluate aircraft weight and balance data for both takeoff and landing.

**TEST DESCRIPTION PROCEDURES**

Unless otherwise noted, all performance tests will be performed with engine operating, landing gear and wing flaps retracted. All data will be hand and voice recorded, and manually reduced to standard aircraft weight and atmospheric conditions. Specific test techniques for each area will be covered in classroom lectures and handouts from references 2, 3, and 4.

#### A. Takeoff Performance

The takeoff ground roll will be determined and hand recorded for each throttle setting.

All takeoffs will be made with 15° of flaps in accordance with the Sierra C24R Airplane Flight Manual.

#### B. Climb Performance

Climb data at different airspeeds will be obtained using sawtooth climbs. Data will be obtained at 2,700 rpm with mixture adjusted for best power at test altitudes of 8,000, 8,500, 9,000 and 9,500 feet. Engine operating limitations as specified in the Flight Manual will be followed.

#### C. Level Turn Performance

Turn performance for the Sierra will be determined from stabilized turns at various altitudes and airspeeds. Data will be obtained at 2,700 rpm, or full throttle, between 7,000 and 10,000 feet. Engine operating limitations as described in the Flight Manual will be followed.

#### D. Cruise Performance

Cruise performance will be evaluated using the  $\dot{V}_{\text{LW}}$  versus  $V_{\text{LW}}$  test technique covered in references 2 and 4. Using the backside trim shot technique, the aircraft will be stabilized at several altitude and airspeed combinations. Data will be obtained at altitudes between 7,000 and 10,000 feet.

#### E. Descent Performance

Descent performance will be determined at various airspeeds at test altitudes of 8,000, 8,500, 9,000 and 9,500 feet. The aircraft will be operated with the throttle at idle and propeller at high pitch for gathering descent data. The Flight Manual restriction concerning prolonged idle settings will be observed.

#### RAFING

Both DFAN faculty pilots will have at least an FAA commercial pilot rating and be current in the Beech Sierra C24R in accordance with FAA and Biedrick Beechcraft Aero Club standards.

All cadets enrolled in Aero 495 will participate in the flying portion of the course as passengers only and will receive appropriate aircraft orientation and safety instruction. All the performance flight test techniques required to gather test data will be covered during classroom lectures prior to the flights for which they will be used.

## CREW DUTIES

### A. Pilot

1. Check local flying weather.
  2. Brief students on mission profile, and ground and in-flight safety.
  3. Check maintenance status of aircraft and perform pre-flight.
  4. Provide a stopwatch.
  5. Provide the tachometer reading at which the aircraft was refueled and the quantity of fuel and oil on board.
  6. Act as pilot in command of the aircraft and occupy the left front seat at all times.
- ### B. Students
1. Bring data cards and a clipboard.
  2. Complete aircraft weight and balance form.
  3. Compute takeoff data using temperature and pressure altitude provided by the pilot.
  4. Provide cassette tape player for each flight. (optional)
  5. Record tachometer reading at which the aircraft was refueled and the quantity of fuel and oil on board.
  6. Cadets will be assigned to two man teams for purposes of taking flight test data. Flight crew duties will be rotated each flight. Along with the pilot who will be primarily concerned with precisely flying the aircraft, both cadets will act as lookouts and notify the pilot immediately of an aircraft sighted. The cadet in the right front seat will act as data observer and timekeeper and the cadet in the rear seat will act as data recorder.

## Safety

Flight personnel will adhere to the following while on the flightline and in and around the aircraft:

- a. Smoking is prohibited in or near the aircraft.
- b. Seat belts will be worn at all times.
- c. Flight personnel will be seated in the aircraft prior to engine start and will remain seated until the engine is stopped.
- d. Remain clear of the propeller area at all times.
- e. Do not stand, walk, or lean on the aircraft except in designated areas.

- i. Do not open aircraft windows or doors in flight.
- ii. Advise the pilot immediately upon observing another aircraft.
- iii. Do not manipulate the aircraft flight controls or engine controls unless told to do so by the pilot.
- iv. Advise the pilot of impending airsickness. Use the bag provided, your hat, your shoe, anything except the floor of the aircraft.
- v. Stay clear of taxiing aircraft and other flightline vehicles.

#### COMMAND AND CONTROL

All testing to be accomplished will be for academic purposes only and will be performed within the restrictions of the Flight Manual, Part 91 of the FAR's, Beechcraft Aero Club Rules and the limitations imposed by this test plan.

All information with respect to this test plan is unclassified.

#### TEST PLAN AMENDMENTS

An amendment to this test plan is required if the flight test envelope is exceeded or if any limitations in the test plan are made less restrictive. An amendment to the test plan must be reviewed and approved by the same authority who approved the basic plan.

REFERENCES

1. Pilot's Operating Handbook and FAA Approved Airplane Flight Manual for the Beechcraft Sierra C24R, Beech Aircraft Corporation, Wichita, Kansas, November 1980.
2. Kimberlin, Ralph D., Performance Flight Testing Lecture Notes, The University of Tennessee Space Institute, Tullahoma, Tennessee, 1982.
3. Performance Theory and Flight Test Techniques, USAF Test Pilot School, Edwards AFB, California, FTC-TIH-79-1, 1 August 1979.
4. Roberts, Sean C., Light Aircraft Performance for Test Pilots and Flight Test Engineers, Flight Research, Inc., Mojave, California, 1980.

## **APPENDIX C**

### **Flight Test Planning Guide Sierra C24R Limited Performance Evaluation**

AERO 495 FLIGHT TEST TECHNIQUES

FLIGHT TEST PLANNING GUIDE

SIERRA C24R LIMITED PERFORMANCE EVALUATION

MAJ CRENSHAW

JUNE 1982

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| <u>CONTENTS</u>                                    | <u>PAGE</u> |
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## FLIGHT 1

### Cruise and Turn Performance

#### I. OBJECTIVES

A. Determine power required as a function of flight speed in order to estimate various aircraft performance parameters.

B. Determine the sustained level turn performance as a function of flight speed and estimate optimum sustained maneuvering speed at test altitude.

#### II. AIRCRAFT

Beechcraft Sierra C24R

#### III. LIMITATIONS

As specified in the test plan.

#### IV. MISSION EVENTS

##### A. Pilot

1. Lineup abeam a runway light prior to brake release for takeoff. Make Flight Manual 15° flap takeoff.

2. Stabilize the aircraft in level flight at a selected test altitude between 7,000 and 10,000 feet.

3. Trim at  $V_{max}$  airspeed at 2,700 rpm/75% MCP, 2,500 rpm/75% MCP, 2,400 rpm/65% MCP and 2,400 rpm/55% MCP. Use the Flight Manual leaning procedure for fuel flow and cruise table for manifold pressure.

4. Trim at different flight velocities at a selected rpm of 2,700, 2,600, 2,500 or 2,400. Do this by varying manifold pressure in 1 inch Hg increments. Do not go below 15" Hg or above 28.7" Hg for any rpm setting. Again, use the Flight Manual leaning procedure for fuel flow.

5. Perform stabilized turns starting from the wings level  $V_{max}$  airspeed at 2,700 rpm/75% MCP. Stabilize at bank angles up to and including 60° in 10° increments.

6. Make normal full stop landing.

##### B. Students

1. Record takeoff ground roll.

2. For each stabilized wings level and turn point, record IAS, pressure altitude, OAT, RPM, MAP, fuel flow and tach time. Also record for turns the time through 360 degrees.

3. Record post flight aircraft tach time.

V. STUDENT POST-FLIGHT DATA REDUCTION

A. Reduce data using the attached data reduction sheets. Use a standard weight of 2,750 lbs where indicated.

B. Plot

1.  $BHP_{iw}$   $V_{iw}^4$  (knots)
2.  $BHP_{iw}$  versus  $V_{iw}$  (knots)
3. SAR versus  $V_{iw}$  (knots)
4. SE versus  $V_{iw}$  (knots)
5.  $C_L^2$  versus  $C_D$
6.  $C_L$  versus  $C_D$
7.  $n_t$  versus VCAS (knots)
8.  $R_t$  versus VCAS (knots)
9.  $\omega_t$  versus VCAS (knots)

C. Determine

1. Sea level maximum range airspeed (knots).
2. Estimated maximum range with 57 gallons of fuel at the test altitude with a 45 minute reserve.
3. Sea level maximum endurance airspeed (knots).
4. Airspeed for maximum range glide, power off (knots).
5. Maximum power-off glide ratio
6. Aircraft efficiency factor.
7. Aircraft drag polar.
8. Airspeed for optimum sustained turn performance at the test altitude (knots).

D. Tabulate the actual true airspeeds versus the Flight Manual predicted true airspeeds from the "Cruise Power Settings" table for 2,700 rpm/75% MCP, 2,500 rpm/75% MCP, 2,400 rpm/65% MCP and 2,400 rpm/55% MCP. Use a standard weight of 2,600 pounds.

E. Complete the "Initial Flight Test Report".

F. Complete a set of sample calculations.

G. Turn in "Initial Flight Test Report" with results, recorded data, data reduction sheets, sample calculations, and plots.

FLIGHT 1 DATA RECORD

1

TAKEOFF DATA: FIELD ELEVATION-6 172 FEET  
DATE

**INSTITUTE OF  
INSTRUCTION**

STUDENTS' CONCERN FOR ENVIRONMENT

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LAKEURF VELD  
VELDARKS:

CRUISE DATA

FLIGHT 1 DATA RECORD

PAGE 2

CRUISE PERFORMANCE DATA REDUCTION

AIRCRAFT: SIERRA C24R

$$\text{WING AREA: } S = 146 \text{ FT}^2$$

STANDARD WEIGHT, 100 = 2,150 . LB

| ①           | ②           | ③           | ④           | ⑤            | ⑥              | ⑦        | ⑧        | ⑨            | ⑩         | ⑪         | ⑫                      | ⑬                     | ⑭   | ⑮                 | ⑯    | ⑰    | ⑱     | ⑲     | ⑳              | ⑷              | ⑵ |
|-------------|-------------|-------------|-------------|--------------|----------------|----------|----------|--------------|-----------|-----------|------------------------|-----------------------|-----|-------------------|------|------|-------|-------|----------------|----------------|---|
| Vi<br>(Kts) | Ve<br>(Kts) | Hi<br>(ft.) | Hc<br>(ft.) | Wt.<br>(lb.) | BHPT<br>(H.P.) | Ti<br>°C | Ta<br>°C | Wf<br>lb/hr. | 6<br>p/po | σ<br>p/po | View<br>BHPiW<br>(Kts) | True<br>View<br>(Kts) | SAR | Propeller<br>CP J | CL D | SE X | VW V4 | VW V3 | BHPiW<br>(Kts) | BHPiW<br>(Kts) |   |

- Vi (Kts.) indicated airspeed
  - $V_c$  (Kts.)  $\approx V_e$  (Kts.) P. 5-10 F.M.
  - Hi (ft.) indicated pressure altitude
  - Hc (ft.) calibrated pressure altitude, P. 5-12 F.M.
  - Test Weight, Wt. = Basic Empty Weight + crew + fuel
  - BHP<sub>t</sub> Test brake H.P. obtained from engine charts
  - Ti Indicated outside air temperature
  - Ta Outside air temperature, °Kelvin
  - $\dot{W}_f$  fuel flow =  $\frac{6 \text{ lb}}{\text{gal}} \times \frac{\text{gal}}{\text{hr}} = 1 \text{ lb./hr.}$
  - pressure ratio, obtained directly from altitude charts & H<sub>c</sub>
  - $\sigma$ , density ratio =  $\frac{\delta}{Ta \sqrt{288.15}}$  =  $\frac{\delta}{10 \sqrt{288.15}}$  ⑧
  - $V_{iw} = Ve \left( \frac{w_s}{w_t} \right)^{\frac{1}{2}} = \textcircled{2} \times \left( \frac{w_s}{\textcircled{3}} \right)^{\frac{1}{2}}$
  - $BHP_{iw} = BHP_t \left( \frac{w_s}{w_t} \right)^{3/2} (\sigma) = \textcircled{6} \times \left( \frac{w_s}{\textcircled{5}} \right)^{3/2} \times \left( \textcircled{11} \right)^{1/2}$
  - $V_{true} \text{ Kts} = \frac{V_e}{\sqrt{\sigma}} = \textcircled{2} \div \left( \textcircled{11} \right)^{\frac{1}{2}}$
  - SAR, Specific Air Range =  $\frac{V_{true}}{\dot{W}_f} = \frac{W_t}{W_s} = (\textcircled{12} \div \textcircled{9}) \text{ NAM / 1b}$  ⑤
  - $C_p$ , Propeller Power Coefficient from charts knowing  $V_e$ , RPM &  $\sqrt{\sigma}$ .
  - J, Propeller Advance Ratio  $\frac{V}{ND}$  from charts knowing  $V_e$ , RPM &  $\sqrt{\sigma}$ .

CRUISE PERFORMANCE DATA REDUCTION

(CONTINUED)

18.  $\eta$ , Propeller Efficiency, from charts knowing  $C_p$  &  $J$ .

$$19. C_L, \text{ Aircraft lift coefficient} = \frac{W_t}{\frac{1}{2} \rho_0 (V_e \times 1.689)^2 S}$$

$$20. C_D, \text{ Aircraft drag coefficient} = \left( \frac{550 \eta \text{ BHP}_t}{V_{\text{true}} \times 1.689} \right) \left( \frac{1}{[\frac{1}{2} \rho_0 (V_e \times 1.689)^2 S]} \right)$$

$$21. \text{ SE, Specific Endurance} = \frac{1}{W_f} \left( \frac{W_t}{S} \right)^{3/2} = \frac{1}{W_f} \left( \frac{5}{W_s} \right)^{3/2} \text{ hr/1b}$$

TURN PERFORMANCE DATA REDUCTION

AIRCRAFT, SIERRA CZIK

WING AREA; S = 146 FT<sup>2</sup>

WING AREA: S = 146 FT<sup>2</sup>

1.  $V_i$  (Kts) indicated airspeed
  2.  $V_c$  (Kts)  $\approx V_e$  (Kts) equivalent airspeed, p. 5-10 F.M.
  3.  $H_i$  (ft) indicated pressure altitude
  4.  $H_c$  (ft) calibrated pressure altitude, p. 5-12 F.M.
  5.  $T_i$  Indicated outside air temperature
  6.  $T_a$  Outside air temperature, °Kelvin
  7.  $\delta$ , pressure ratio, obtained from altitude charts and  $H_c$
  8. ... density ratio  $= \frac{\delta}{T_3} \frac{K/288.15}{K/288.15} = \frac{\delta}{1}$
  9.  $V_{true}$  fps  $= \frac{V_e}{\sqrt{g}} 1.689 = \left( \frac{V_e}{\sqrt{g}} \div (8) \right)^{\frac{1}{2}} 1.689$
  10. Time to turn through  $360^\circ$
  11.  $\omega_t = \frac{360^\circ}{\text{TIME}} = \frac{360^\circ}{(10)} \text{ deg/sec}$
  12.  $n_t = \sqrt{\frac{\omega_t V_{true}}{57.296 \times g}} + 1 = \sqrt{\frac{(1) \times (9)}{57.296 \times g}} + 1$
  13.  $R_t = \frac{V_{true}}{\omega_t} 57.296 = (9) \div (11) \times 57.296$

FLIGHT 2

Climb and Descent Performance

I. OBJECTIVES

A. Determine maximum rate of climb and maximum angle of climb and respective airspeeds at which they occur.

B. Determine best glide speed, best no wind glide ratio and minimum sink rate and speed with propeller windmilling. Produce a propeller windmilling drag polar for the aircraft.

II. AIRCRAFT

Beechcraft Sierra C24R

III. LIMITATIONS

As specified in the Test Plan.

IV. MISSION EVENTS

A. Pilot

1. Lineup abeam a runway light prior to brake release for takeoff. Make normal 15° flap takeoff.

2. For climbs, set RPM at 2,700 and adjust mixture for best power. Stabilize the aircraft in a steady climb at airspeeds of 70, 80, 90, 100 and 110 knots on a heading perpendicular to the wind direction. At 500 feet below the test altitude, set full throttle and climb to 500 feet above the test altitude. Also establish level flight speed at the test altitude using climb power. Test altitudes are 8,000, 8,500, 9,000 and 9,500 feet.

3. For descents, fly power-off glides (throttle idle, propeller high pitch) in 10 knot increments from 120 knots to 80 knots from 500 feet above to 500 feet below the test altitude. Test altitudes are 8,000, 8,500, 9,000 and 9,500 feet.

4. Make normal full stop landing.

B. Students

1. Record takeoff ground roll.

2. During climbs, record the time to climb through 1,000 feet with a stopwatch. Also record tach time and OAT at 500 feet below the test altitude, at the test altitude, and 500 feet above the test altitude. Record RPM and MAP at the test altitude. Record the climb rate indicated on the Vertical Velocity Indicator (VVI) and elapsed time at each 100 feet. Note the maximum velocity at climb power in level flight at the test altitude.

3. During glides, time the glide through 1,000 feet of descent with a stopwatch. Record each time and OAT at 500 feet above the test altitude, at the test altitude and at 500 feet below the test altitude. Also record VVI and elapsed time every 100 feet.

4. Record post flight aircraft tachometer time.

V. STUDENT POST-FLIGHT DATA REDUCTION

A. Reduce data using the attached data reduction sheets. Use a standard weight of 2,750 lbs where indicated.

B. Plot

1.  $(R/C)_T$  versus IAS (knots)
  2.  $(R/C)_S$  versus  $V_{IW}$  (knots)
  3. L/D versus  $V_{IW}$  (knots)
  4.  $C_D$  versus  $C_L^2$  (drag polar)
  5. Sink rate (ft/min) versus  $V_{IW}$  (knots)
- } for descents

C. Determine

1. Airspeed for best rate of climb and for best angle of climb on both plots of  $(R/C)_T$  and  $(R/C)_S$ .

2. Airspeed for max glide range and minimum sink.

D. Complete the "Initial Flight Test Report".

E. Complete a set of sample calculations.

F. Turn in "Initial Flight Test Report" with results, recorded data, data reduction sheets, sample calculations and plots.

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## CLIMB DATA

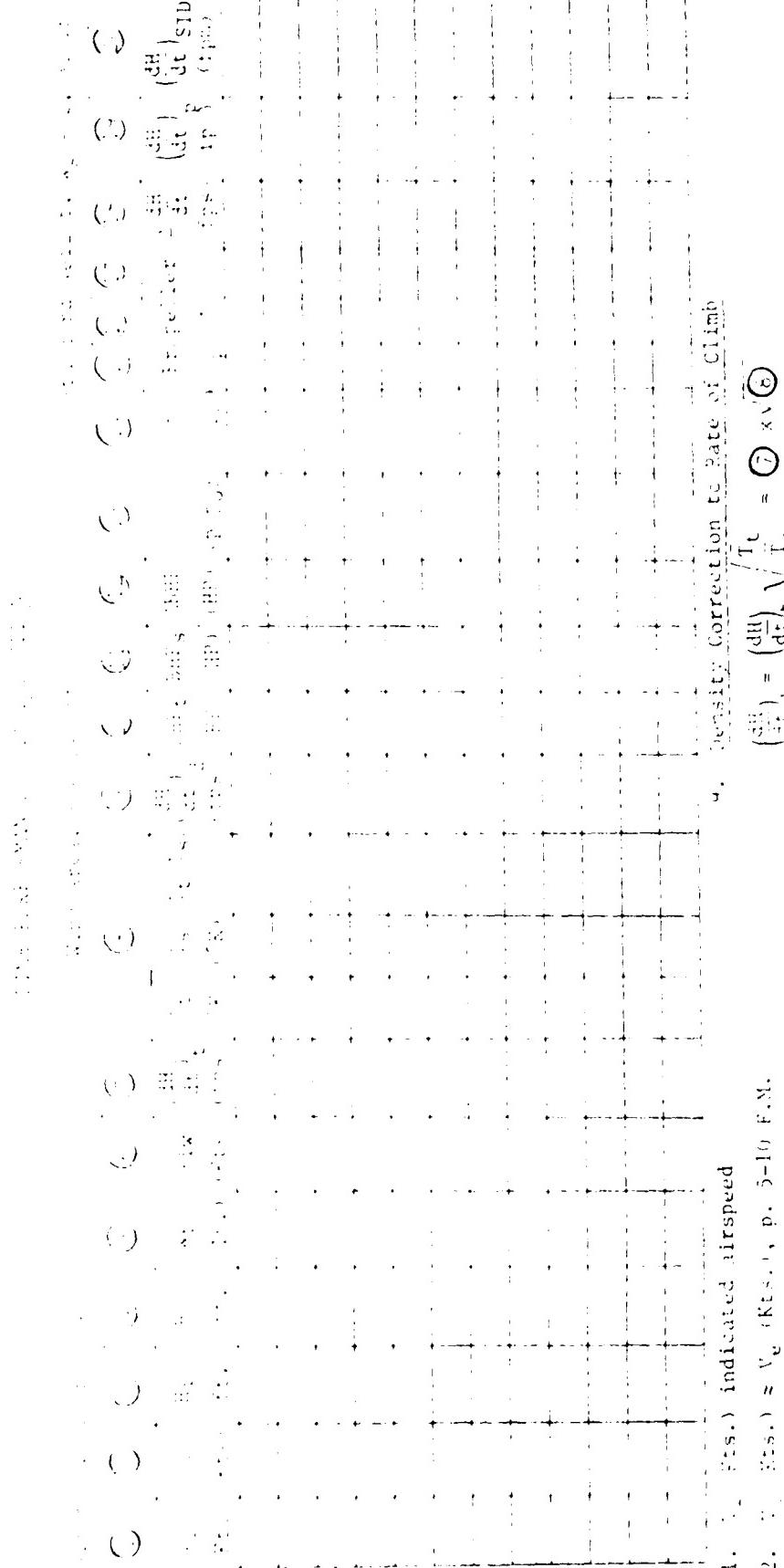
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THE JOURNAL OF CLIMATE

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BAUDISCHEN WERKE

22; 1955) ≈ V<sub>2</sub> (Kets, 1955-56).

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APPLIED SENSITIVE PERIODS

Calibrated pressure altitude,  $\text{ft} \pm 12 \text{ ft}$

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THE SOUTHERN HISTORICAL JOURNAL

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THE JOURNAL OF CLIMATE

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SIGHTING RECORDS FROM THE MOUNTAINS OF SOUTHERN CHINA

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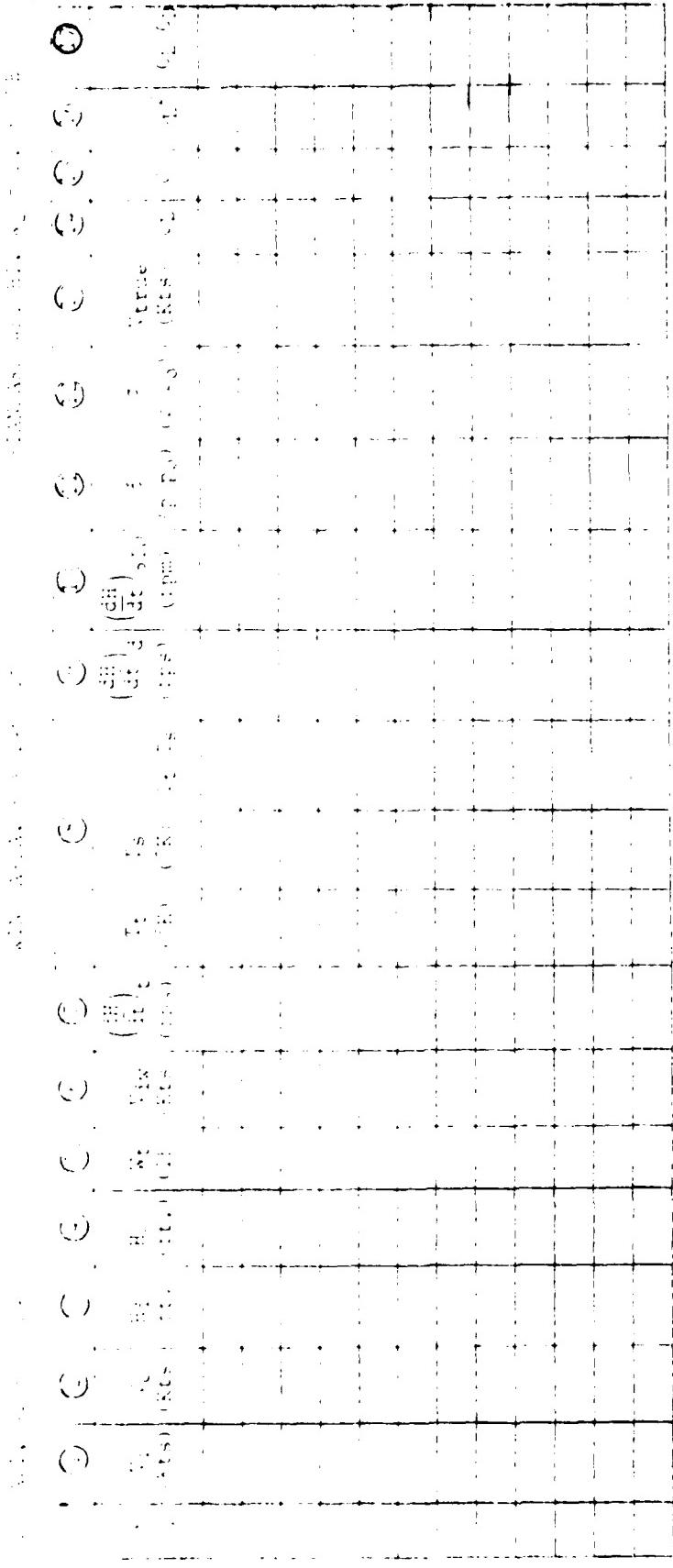
absolute temperature of test electrode

Plot He versus time. Draw a tangent at the initial point (0).

absolute temperature of test electrode

C-16

17.  $\frac{dH}{dt} = \frac{dH}{dt} + \frac{dH}{dt} = \frac{dH}{dt}$  (Rate of Change of Health)  $=$  Rate of Change of Health
18.  $\frac{dH}{dt} = \frac{dH}{dt} + \frac{dH}{dt} = \frac{dH}{dt}$  (Rate of Change of Health)  $=$  Rate of Change of Health
- $$\left( \frac{dH}{dt} \right)_{\text{Rate}} = \frac{dH}{dt} \left[ \frac{dH}{dt} + \frac{dH}{dt} \left( 1 - \frac{dH}{dt} \right) \right] \quad \text{Equation 17}$$
- $$\left( \frac{dH}{dt} \right)_{\text{Rate}} = \frac{dH}{dt} \left[ \frac{dH}{dt} + \frac{dH}{dt} \left( 1 - \frac{1}{dH} \right) \right] \quad \text{Equation 18}$$
- $$19. \left( \frac{dH}{dt} \right)_{\text{Rate}} = \left( \frac{dH}{dt} \right)_{\text{Rate}} + \left( \frac{dH}{dt} \right)_{\text{Rate}} = \textcircled{9} + \textcircled{10}$$
20. Neglect Correction to Rate of Change
- $$\left( \frac{dH}{dt} \right)_{\text{Rate}} = \left( \frac{dH}{dt} \right)_P \sqrt{\frac{K_S}{K_T}} \text{Rate} = \textcircled{12} \times V^{\frac{K_S}{K_T}} \text{Rate} \quad (\text{FPM})$$



11 (KTS) indicated airspeed

2. (KCS.) indicated airspeed

(Kts.) indicated airspeed

### Density Correction to Rate of Descent

$$\text{②} \wedge x \sqrt{\text{③}} = \bigwedge_{i=1}^n \left( \frac{P_i P}{H_i P} \right) = \frac{P \cdot P}{H P}$$

$$\text{Weight Correction} = \frac{\partial H}{\partial t_{SP}} = \left( \frac{\partial H}{\partial t} \right) \sqrt{\frac{s}{s+1}} \cdot \alpha = \Theta \quad (6)$$

Fig. 1. Pressure ratio from altitude charts for Hg.

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$$C_2 = \frac{1}{V_{\text{ext}}^2} \cdot \left( \frac{N_e}{N_e + 1.589} \right)^2 \approx \frac{1}{2} \cdot \frac{1}{2} = \frac{1}{4} \quad (2) \times \frac{1}{1.68975} \quad (5)$$

15.  $\frac{d}{dt} \left( \frac{\partial H}{\partial p_i} \right)_{\text{ext}} = \frac{d}{dt} \left( \frac{\partial H}{\partial p_i} \right)_{\text{int}} + \frac{d}{dt} \left( \frac{\partial H}{\partial p_i} \right)_{\text{ext}} - \frac{d}{dt} \left( \frac{\partial H}{\partial p_i} \right)_{\text{int}}$

$\frac{d}{dt} \left( \frac{\partial H}{\partial p_i} \right)_{\text{ext}} = \frac{d}{dt} \left( \frac{\partial H}{\partial p_i} \right)_{\text{int}} + \frac{d}{dt} \left( \frac{\partial H}{\partial p_i} \right)_{\text{ext}} - \frac{d}{dt} \left( \frac{\partial H}{\partial p_i} \right)_{\text{int}}$

REFERENCES

- (1) Flight Test Engineering Handbook, Air Force Flight Test Center, Edwards AFB, California, TR 6273, January 1965.
- (2) Robertry, Sean C., *Light Aircraft Performance for Test Pilots and Flight Test Engineers*, Flight Research, Inc., Mojave, California, 1980.
- (3) Elliott, V. W., FA-41, *Elements of Flight Test Engineering*, United States Naval Academy, Annapolis, Maryland, 1981.

## INITIAL FLIGHT TEST REPORT

1. AIRCRAFT TYPE

2. SERIAL NUMBER

## CONDITIONS RELATIVE TO TEST

e. CONFIGURATION:

i. FUEL LOAD:

f. INSTRUMENTATION:

j. SURFACE WIND:

g. START UP GR WT:

k. WEATHER:

h. START UP C.G.:

l. GROUND BLOCK:

TESTS PERFORMED

5. RESULTS OF TESTS (Continue on reverse side if needed)

6. MARKS (Continue on reverse side if needed)

## **APPENDIX D**

**Sample Performance Data Records,  
Data Reduction and Plots**

Contents

|   | <u>Page</u> |
|---|-------------|
| *Flight 1 - Cruise and Turn Performance   | D-3         |
| *Flight 2 - Climb and Descent Performance   | D-15        |
| * Note that the data records for both of these flights show only<br>a sample of the actual data taken on the dates indicated. As<br>the plots derived from both flights indicate, several more data<br>runs were performed. |             |

21 Sept '82

Crenshaw  
Webster  
Goodwin

ASR 3600 N 66 36 0

ASR-PILOT LAG TIME 885.88

PILOT-PILOT LAG TIME 886.94

RESULTS: *Test Altitude = 10000 ft*  
*pressure altitude*

ASR 3600 30.36

ASR-PILOT 010/6 knots

PILOT ASR 5700 ft

TEMP 41° F

(A) ROLL (P) 1600 ft

(D) ROLL (A) 1450 ft

LAKOFF V1 6.6 knots

CRUISE DATA

| FLY. | IAS<br>KTS | CRU<br>TIME | CRU<br>ALT<br>FT | MAP<br>ALT<br>IN. | PP<br>RPM | GPH  | PP<br>REMARKS |
|------|------------|-------------|------------------|-------------------|-----------|------|---------------|
| 1    | 107        | 886.21      | 10,000           | 20                | 2600      | 10.5 |               |
| 2    | 100        | 886.42      | 10,000           | 18                | 2600      | 9.0  |               |
| 3    | 79         | 886.53      | 10,000           | 15                | 2600      | 7.0  |               |

| Altitude, ft. | Velocity, ft./sec. | Velocity, Kts. | Velocity, M. | Velocity, ft./min. | Velocity, ft./hr. | Velocity, ft./sec. | Velocity, ft./min. | Velocity, ft./hr. | Velocity, ft./sec. | Velocity, ft./min. | Velocity, ft./hr. | Velocity, ft./sec. | Velocity, ft./min. | Velocity, ft./hr. | Velocity, ft./sec. | Velocity, ft./min. | Velocity, ft./hr. | Velocity, ft./sec. | Velocity, ft./min. | Velocity, ft./hr. |
|---------------|--------------------|----------------|--------------|--------------------|-------------------|--------------------|--------------------|-------------------|--------------------|--------------------|-------------------|--------------------|--------------------|-------------------|--------------------|--------------------|-------------------|--------------------|--------------------|-------------------|
| 10000         | 107.106            | 10K.99982712   | 1.34.3       | 10283              | 63                | .68778             | .7003106.7114.8    | .16667            | .98.954.78         | .85.9              | .253.016          | .12249             | .1.3E08            |                   |                    |                    |                   |                    |                    |                   |
| 10000         | 100.99             | 10K.99982700   | 1.16.8       | 10283              | 54                | .68778             | .7003              | .99.91002.5       | .11830             | .2.15.047.73       | .82.              | .86.053.081000     | .010.996607        |                   |                    |                    |                   |                    |                    |                   |
| 10000         | 99.78              | 10K.99972695   | 88.6         | 10283              | 42                | .68778             | .7003              | .78.8             | .76.4              | .217.035.57        | .79.              | .82.011.023        | .7121.3.86E07      |                   |                    |                    |                   |                    |                    |                   |
| 10000         | 99.78              | 10K.99972695   | 88.6         | 10283              | 42                | .68778             | .7003              | .78.8             | .76.4              | .217.035.57        | .79.              | .82.011.023        | .7121.3.86E07      |                   |                    |                    |                   |                    |                    |                   |

D-2

1.  $V_i$  (Kts.) indicated airspeed
2.  $V_c$  (Kts.)  $\approx V_e$  (Kts.) P. 5-10 F.M.
3.  $H_i$  (ft.) indicated pressure altitude
4.  $H_c$  (ft.) calibrated pressure altitude, p. 5-12 F.M.
5. Test Weight,  $W_t$  = Basic Empty Weight + fuel
6.  $BHP_t$  test brake H.P. obtained from engine charts
7.  $T_i$  indicated outside air temperature
8.  $T_a$  outside air temperature, ° Kelvin
9.  $\dot{m}_t$  fuel flow =  $\frac{lb}{gal} \times gal$  =  $lb$ , hr.
10.  $\delta$ , pressure ratio, obtained directly from altitude charts &  $H_i$ .

11.  $\sigma$ , density ratio =  $\frac{T_a}{T_i} \times \frac{\gamma_{air}}{\gamma_{gas}}$  =  $\frac{1}{\delta} \times \frac{\gamma_{air}}{\gamma_{gas}}$
12.  $V_{iw}$  =  $V_c \left( \frac{w_s}{w_t} \right)^{\frac{1}{2}}$  =  $\frac{V_c}{\delta} \times \left( \frac{w_s}{w_t} \right)^{\frac{1}{2}}$
13.  $BHP_{iw}$  =  $BHP_t \left( \frac{w_s}{w_t} \right)^{3/2}$  (σ)  $\frac{1}{\delta} = \frac{BHP_t}{\delta} \times \left( \frac{w_s}{w_t} \right)^{\frac{3}{2}}$
14.  $\text{true } R_t = \frac{V_c}{\delta G} = \frac{V_c}{\frac{P}{\rho} \times \frac{G}{w_t}}$
15. SAR, Specific Air Range =  $\frac{\text{true } R_t}{w_t}$  =  $\frac{V_c}{P} \times \frac{G}{w_t}$
16. Propeller Power Coefficient from charts  $K_p$ ,  $BHP_t$ , RPM & σ.
17. 1, Propeller Advance Ratio  $\frac{V_c}{RPM \sqrt{\sigma}}$  from charts  $K_1$ ,  $RPM$  &  $\sqrt{\sigma}$

$$\frac{P}{V} = \frac{\rho_0}{\rho} \left( \frac{V_0}{V} \right)^{\frac{1}{k}} \quad \text{or} \quad \frac{P}{V} = \frac{\rho_0}{\rho} \left( \frac{V_0}{V} \right)^{\frac{1}{k}}$$

18.  $\eta_p$ , propeller efficiency, from charts known to be true.

$$19. \eta_{air}$$
, air craft lift coefficient =  $\frac{1}{2} \frac{\rho_0 (V_e - V_s)^2}{S} C_L$

$$20. \eta_{true}$$
, air craft drag coefficient =  $\frac{(1.550 + B/H)t_d}{(\text{true } \times 1.039)}$   $\left( \frac{1}{2} \rho_0 (V_e - V_s)^2 \right)$

$$21. \eta_{sp}$$
, specific Endurance =  $\frac{1}{\eta_{air}} \left( \frac{\eta_p}{\eta_s} \right)^{3/2} = \frac{1}{\eta_{air}} \left( \frac{\eta_p}{\eta_s} \right)^{3/2} \text{ hr/lb}$

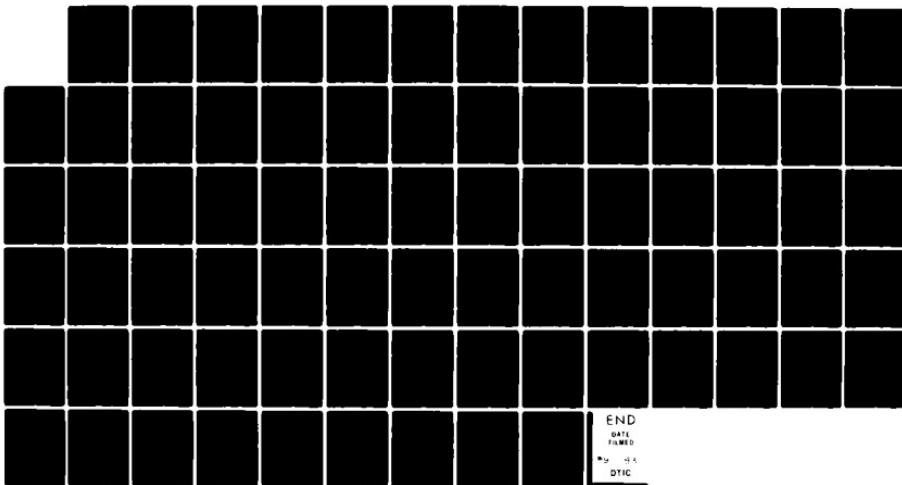
AD-A131 457 AIRBORNE LABORATORY MEASUREMENT OF AIRCRAFT PERFORMANCE  
AND STABILITY AND CONTROL FOR LIGHT AIRCRAFT SUPPLEMENT  
(U) AIR FORCE ACADEMY CO K R CRENSHAW 24 JUN 83

UNCLASSIFIED USAFA-TN-83-3

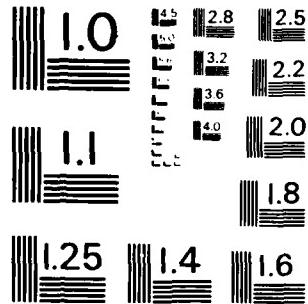
F/G 14/2

2/2

NL



END  
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MAY - 14  
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MICROCOPY RESOLUTION TEST CHART  
NATIONAL BUREAU OF STANDARDS - 1963 - A

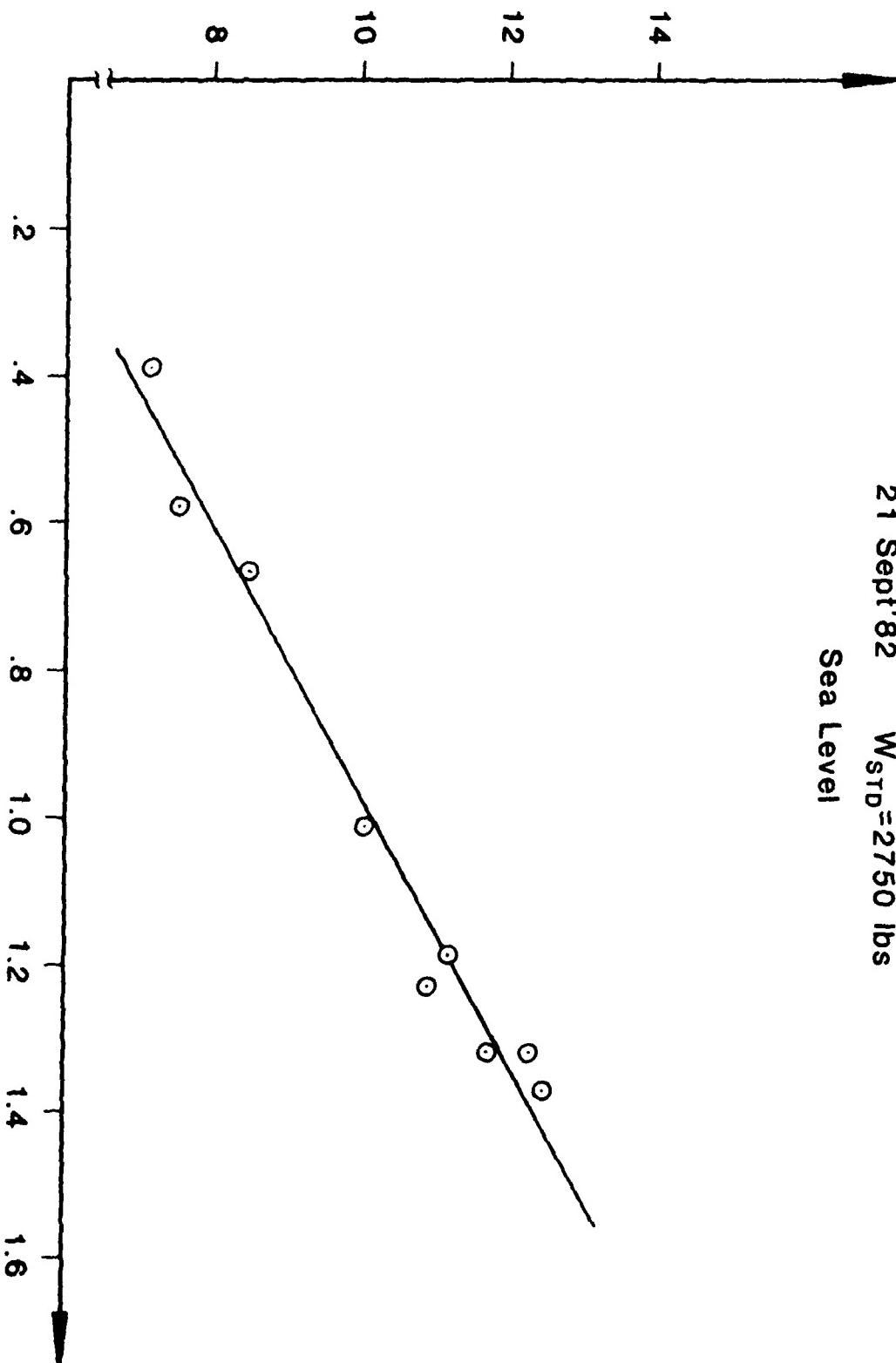
Beechcraft Sierra N6636D

21 Sept'82       $W_{STD} = 2750$  lbs

Sea Level

$$BHP_{iw} \times V_{iw} (HP-KTS) \times 10^{-3}$$

$$V_{iw}^4 (KTS)^4 \times 10^{-8}$$



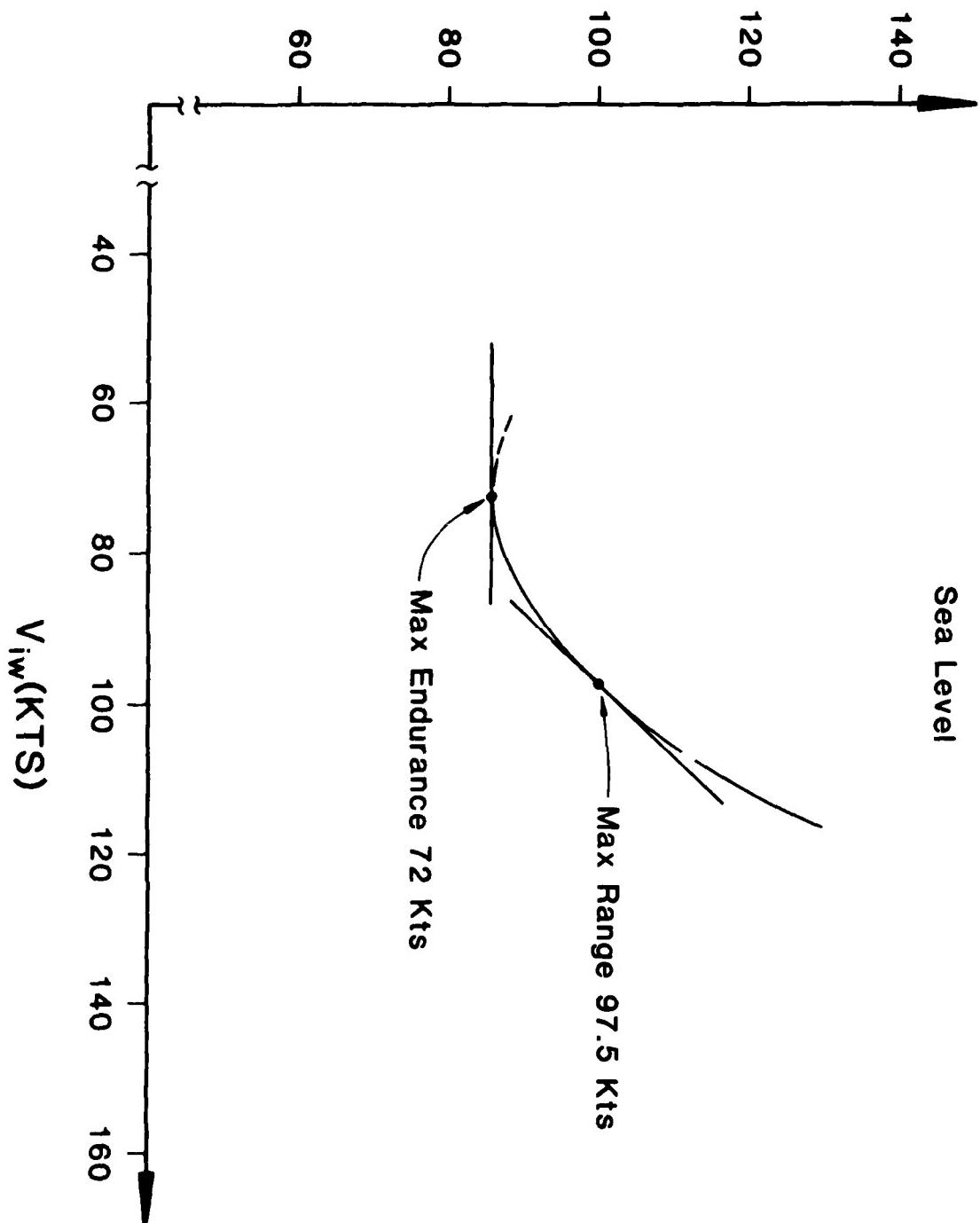
D-6

Beechcraft Sierra N6636D

21 Sept '82 W<sub>STD</sub>=2750 lbs

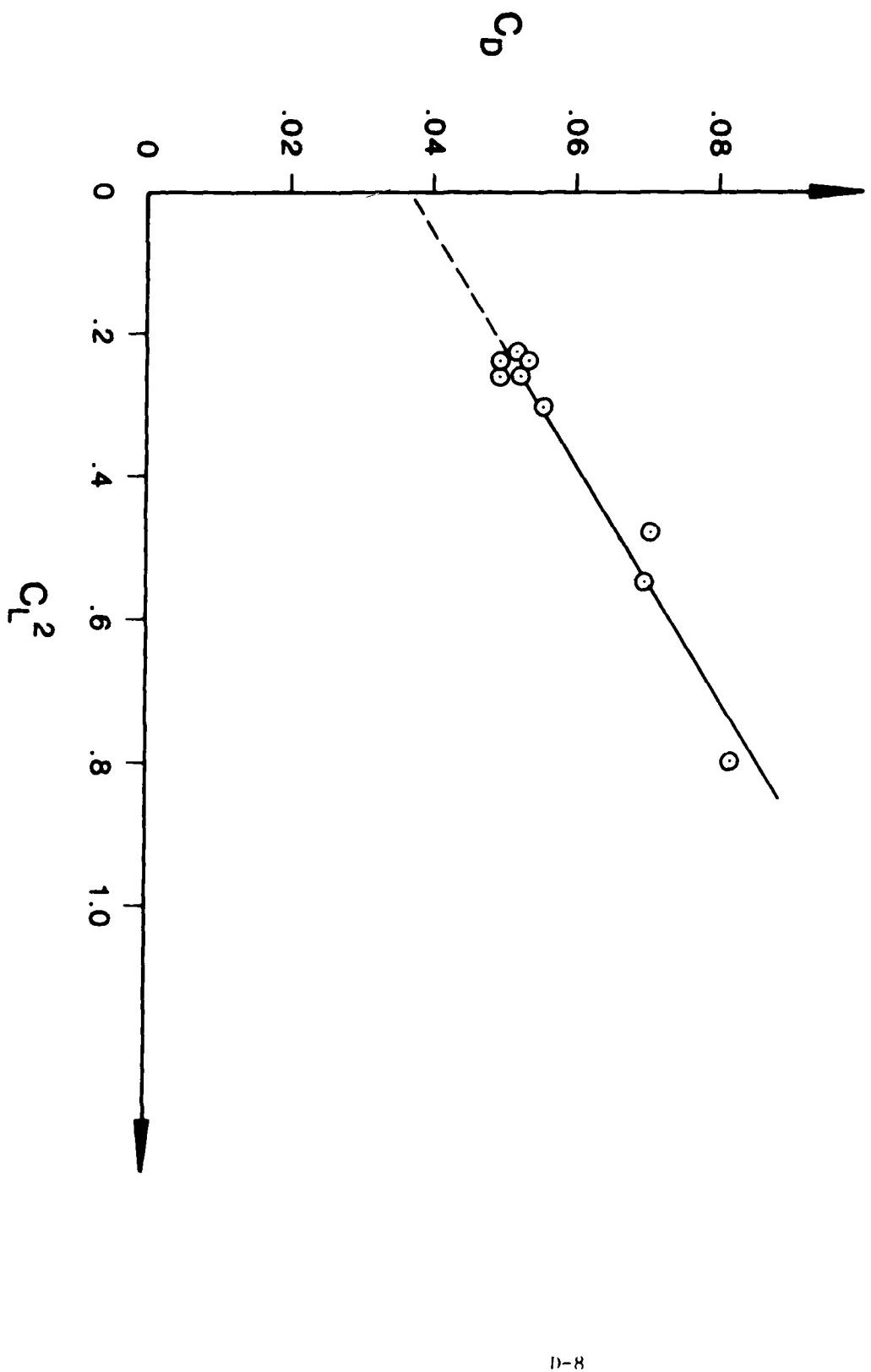
Sea Level

BHP<sub>iw</sub>(HP)



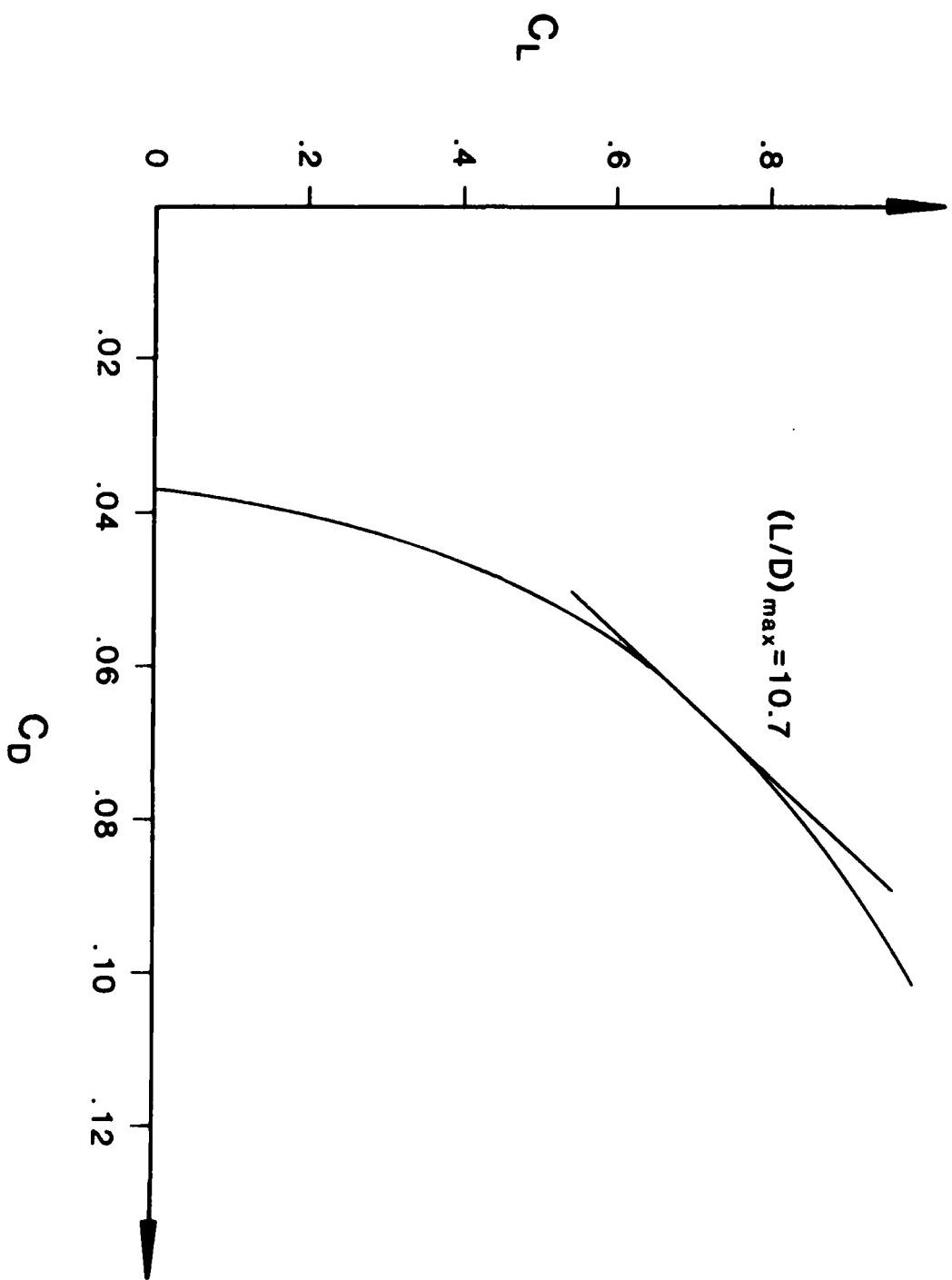
Beechcraft Sierra N6636D

21 Sept'82     $C_D = .037 + .06C_L^2$



Beechcraft Sierra N6636D

21 Sept'82       $C_D = .037 + .06C_L^2$



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DATA SHEET FOR AIRPLANE COMPUTATION

| Altitude, ft. (ft.) | Indicated airspeed, Kts. (Kts.) | Calibrated pressure altitude, ft. (ft.) | Outside air temperature, °K. (°C.) | True air temperature, °K. (°C.) | True airspeed, Kts. (Kts.) | Time, sec's. (sec's.) | Time, deg sec's. (deg sec's.) |
|---------------------|---------------------------------|---|------------------------------------|---------------------------------|----------------------------|-----------------------|-------------------------------|
| 108                 | 102                             | 10,000                                  | 99.98                              | 10                              | 283                        | 6878                  | 1003 215.96                   |
| 104                 | 103                             | 10,000                                  | 99.98                              | 10                              | 283                        | 6878                  | 1003 207.89                   |
| 96                  | 95                              | 10,000                                  | 99.98                              | 10                              | 283                        | 6878                  | 1003 191.74                   |

D-11

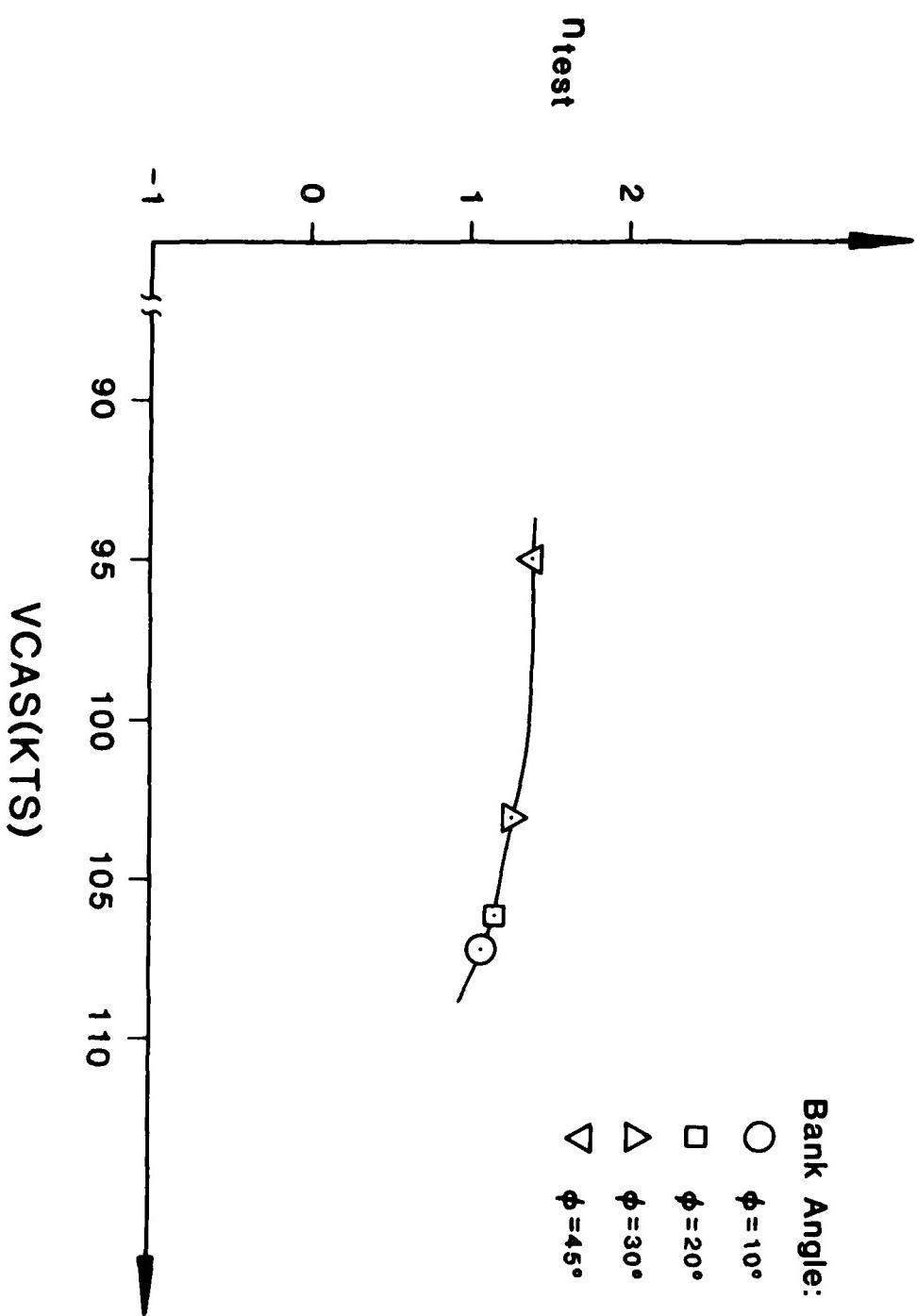
1.  $V_i$  (Kts) indicated airspeed
2.  $V_c$  (Kts)  $\approx V_e$  (Kts) equivalent airspeed, p. 5-10 F.M.
3.  $H_i$  (ft) indicated pressure altitude
4.  $H_c$  (ft) calibrated pressure altitude, p. 5-12 F.M.
5.  $T_i$  Indicated outside air temperature
6.  $T_a$  Outside air temperature, °Kelvin
7.  $\delta$ , pressure ratio, obtained from altitude charts and  $H_c$
8.  $\gamma$ , density ratio =  $\frac{\delta}{T_a - \frac{6}{\delta} \frac{288.15}{288.15}}$  =  $\frac{7}{7} \times \frac{288.15}{288.15}$

9.  $V_{true}$  fpm =  $\frac{V_e}{\sqrt{\frac{P_1}{P_0}}} 1.689 = (\frac{V_e}{\sqrt{\frac{P_1}{P_0}}})^2 1.689$
10. Time to turn through 360°
11.  $\omega_t = \frac{360^\circ}{\text{TIME}} = \frac{360^\circ}{\text{TIME}} \text{ deg/sec}$
12.  $n_t = \sqrt{\left(\frac{V_{true}}{57.296 \times \omega_t}\right)^2 + 1} = \sqrt{\left(\frac{V_{true}}{57.296 \times \frac{360^\circ}{\text{TIME}}}\right)^2 + 1}$
13.  $R_t = \frac{V_{true}}{\omega_t} 57.296 = (\frac{V_{true}}{\sqrt{\frac{P_1}{P_0}}})^2 57.296 = (\frac{V_{true}}{\sqrt{\frac{P_1}{P_0}}})^2 \times 57.296$

Beechcraft Sierra N6636D

21 Sept'82  $H_{test} = 10,000$  feet

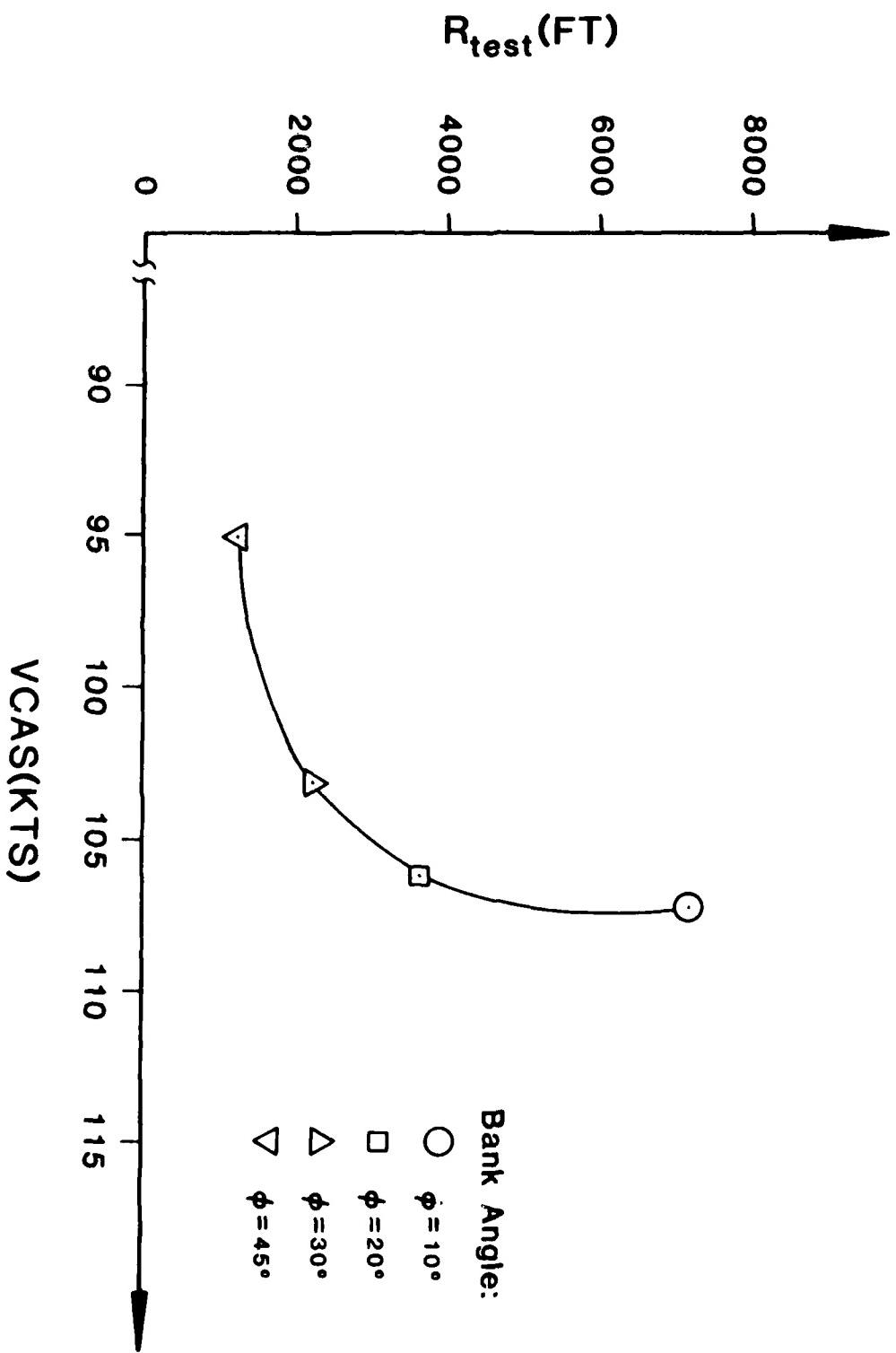
Steady Turns



Beechcraft Sierra N6636D

21 Sept'82     $H_{test} = 10,000$  feet

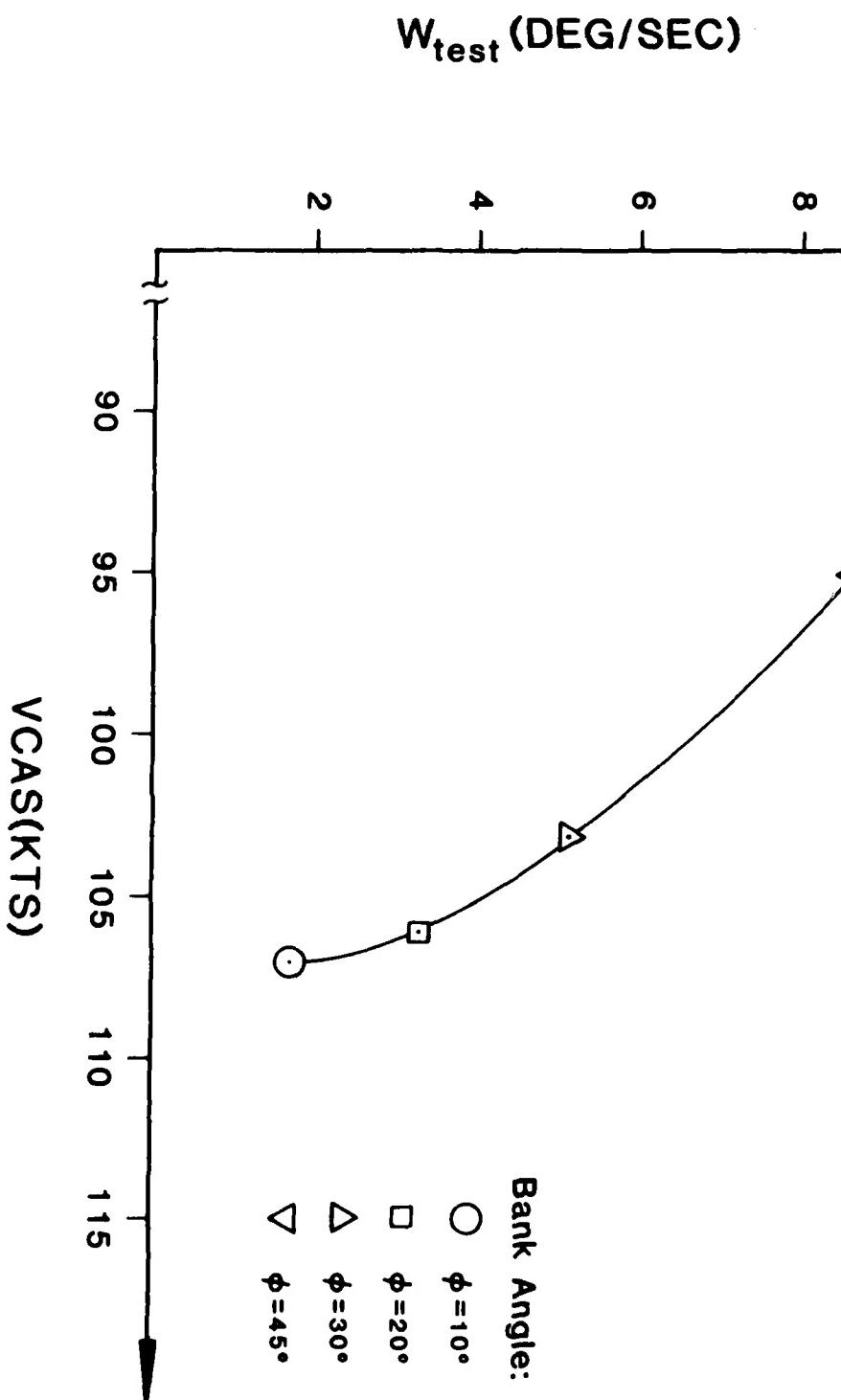
Steady Turns



Beechcraft Sierra N6636D

21 Sept'82       $H_{test} = 10,000$  feet

Steady Turns



18 Feb 83

Crenshaw

INSTR. IN

Muller

STUDENT

Koehn

REMARKS:

AIRCRAFT NO. N18892

PRE-FLIGHT TACH TIME 1644.53

POST-FLIGHT TACH TIME 1645.37

REMARKS:

AFB, AF DATA FIELD FRENCHMAN, LA, USA

ALTITUDE 29.99

WINDS 320/5 knots

PRESS. ALT. 6000 ft

TEMP 34°F

GD ROLL (P) 2200 ft

GD ROLL (A) 1900 ft

TAKOFF V<sub>1</sub> 26 mph

TIME DATA

| RUN<br>NO. | IAS<br>MPH | TACH<br>TIME | ALT.<br>FT. | TOTAL<br>TIME | RPM   |             |      |      | VVI (FPM) / ELAPSED TIME (SEC'S) |      |      |      |      |
|------------|------------|--------------|-------------|---------------|-------|-------------|------|------|----------------------------------|------|------|------|------|
|            |            |              |             |               | MAP   | MAP<br>SECS | FF   | -400 | -300                             | -200 | -100 | ALT  | +100 |
| 1          | 81         | 1644.78      | +10 +9 +8   | 116           | 20/10 | 60/2        | 53/2 | 51/2 | 53/3                             | 53/5 | 53/2 | 53/2 | 53/2 |
| 2          | 100        | 1644.94      | +10 +9 +9   | 132           | 26/50 | 19/9        | 70/1 | 53/2 | 51/2                             | 48/1 | 50/2 | 51/0 | 45/0 |
| 3          | 125        | 1645.16      | +11 +10 +8  | 267           | 2700  | 150         | 380  | 19/2 | 20/1                             | 20/2 | 16/1 | 16/2 | 16/2 |
| 4          |            |              |             |               |       |             |      |      |                                  |      |      |      |      |
| 5          |            |              |             |               |       |             |      |      |                                  |      |      |      |      |
| 6          |            |              |             |               |       |             |      |      |                                  |      |      |      |      |
| 7          |            |              |             |               |       |             |      |      |                                  |      |      |      |      |
| 8          |            |              |             |               |       |             |      |      |                                  |      |      |      |      |
| 9          |            |              |             |               |       |             |      |      |                                  |      |      |      |      |
| 10         |            |              |             |               |       |             |      |      |                                  |      |      |      |      |

CLIMB PERFORMANCE DATA SHEET

| Aircraft, Serial No. | Standard Altitude, ft. | Flight Altitude, ft. |       |       |       |       |          |                 |         |         |                 |
|----------------------|------------------------|----------------------|-------|-------|-------|-------|----------|-----------------|---------|---------|-----------------|
|                      |                        | $V_i$                | $V_c$ | $H_i$ | $H_c$ | $W_t$ | $V_{iw}$ | $\frac{dH}{dt}$ | $BHP_s$ | $BHP_t$ | $\frac{dH}{dt}$ |
| (Kts.)               | (ft.)                  | (ft.)                | (ft.) | (lb.) | (ft.) | (ft.) | (ft.)    | (ft.)           | (hp)    | (hp)    | (ft.)           |
| 70.3                 | 69.8                   | 8500                 | 8494  | 2572  | 22.2  | 8.62  | 282      | 288             | 979     | 844     | 131             |
| 86.8                 | 86.0                   | 8500                 | 8498  | 2562  | 89.1  | 7.58  | 222      | 288             | 979     | 742     | 128             |
| 108.5                | 108.0                  | 8500                 | 8498  | 2550  | 112.2 | 3.75  | 223      | 288             | 983     | 3.67    | 133             |

D-16

1.  $V_i$  (Kts.) indicated airspeed
2.  $V_c$  (Kts.)  $\approx V_e$  (Kts.), p. 5-10 F.M.
3.  $H_i$  (ft.) indicated pressure altitude
4.  $H_c$  (ft.) calibrated pressure altitude, p. 5-12 F.M.
5. Test Weight,  $W_t$  = Basic Empty Weight + crew + fuel
6.  $V_{iw} = V_e \left( \frac{W_s}{W_t} \right)^{\frac{1}{2}} = \textcircled{2} \times \left( \frac{W_s}{\textcircled{5}} \right)^{\frac{1}{2}}$
7.  $\frac{dH}{dt}_t$  Plot  $H_c$  versus time. Draw a tangent to the curve at test altitude. Slope is  $\left( \frac{dH}{dt} \right)_t$
8.  $\frac{T_t}{T_s}$  Absolute Test Temperature at test altitude
9. Density Correction to Rate of Climb
10.  $BHP_t$  from engine chart for actual test altitude temperature
11.  $BHP_s$  from engine chart for standard temperature at test altitude
12.  $BHP_s = BHP_t \sqrt{\frac{T_t}{T_s}} = \textcircled{7} \times \sqrt{\textcircled{8}}$
13.  $\zeta$ , pressure ratio from altitude charts for  $H_c$
14.  $\zeta$ , density ratio  $= \frac{T_t}{T_s} \times \frac{288.15}{288.15} = \frac{\textcircled{1} \times 288.15}{\textcircled{1} \times 288.15} = \frac{\textcircled{1}}{\textcircled{1}}$
15. C<sub>p</sub>, Propeller Power Coefficient knowing BHP<sub>t</sub>, RPM and  $\zeta$
16. J, Propeller Advance Ratio knowing  $V_e, \sqrt{\zeta}$  and RPM

17. Propeller efficiency knowing  $\eta_p$  and  $\dot{V}_s$
18. Engine Power and Propulsive Efficiency Correction to Rate of Climb

$$\therefore \left( \frac{dH}{dt} \right) = \frac{\eta}{\eta_S} \left[ BHP + BHP_S \left( 1 - \frac{\dot{V}_s}{V_t} \right) \right] \times 50$$

$$\therefore \left( \frac{dH}{dt} \right) = \textcircled{17} \left[ \textcircled{2} + \textcircled{11} \left( 1 - \frac{1}{8} \right) \right] \times 50$$

$$19. \left( \frac{dH}{dt} \right)_p = \left( \frac{dH}{dt} \right)_d + \left( \frac{dH}{dt} \right)_w = \textcircled{9} + \textcircled{18}$$

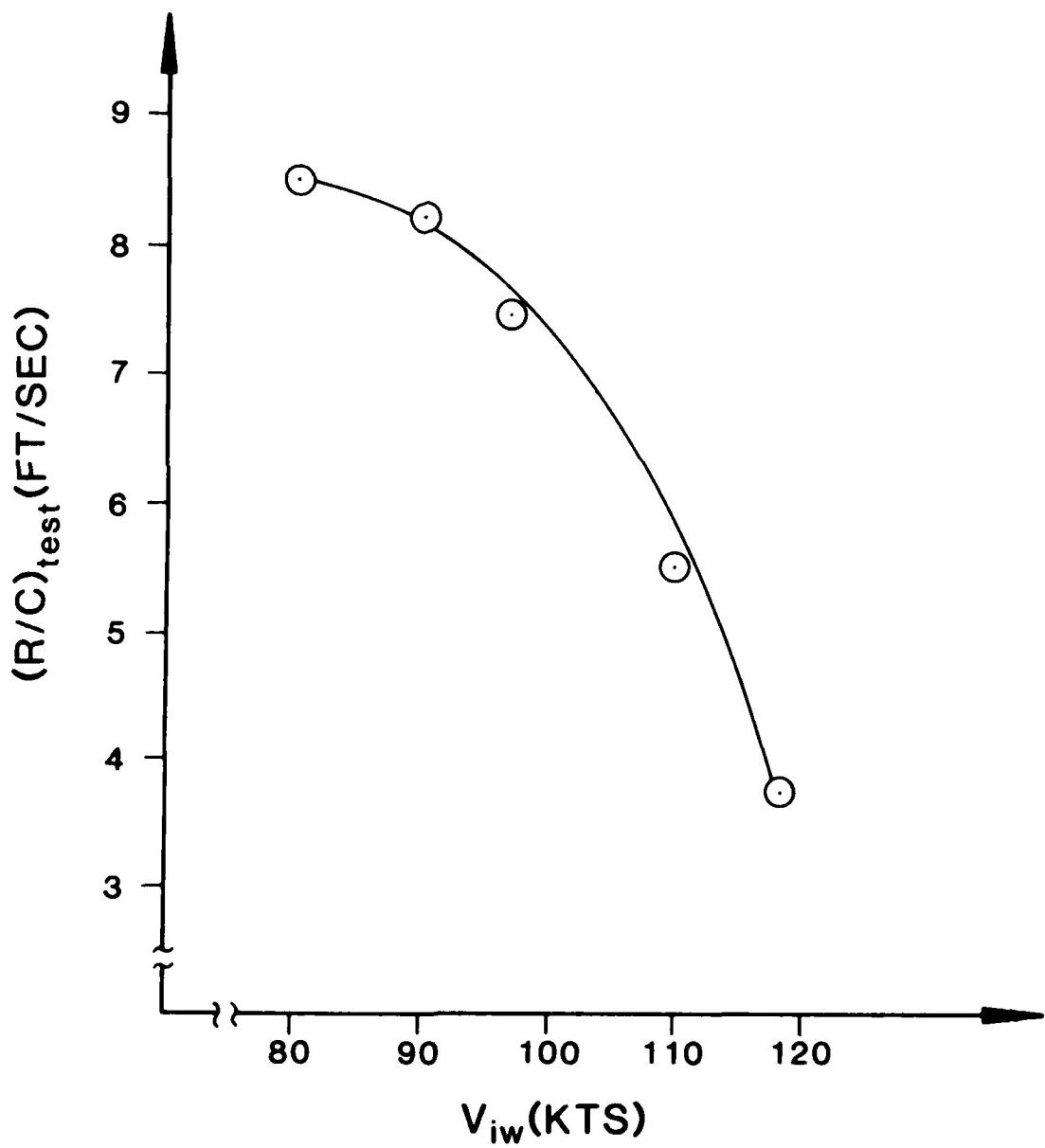
20. Weight Correction to Rate of Climb

$$\left( \frac{dH}{dt} \right)_{WT} = \left( \frac{dH}{dt} \right)_p \sqrt{\frac{W_s}{W_t}} \times 60 = \textcircled{19} \times \sqrt{\frac{W_s}{\textcircled{5}}} \times 60 (\text{FPM})$$

Beechcraft Sierra N18892

21 Feb'83     $H_{test} = 8500$  feet

Sawtooth Climbs



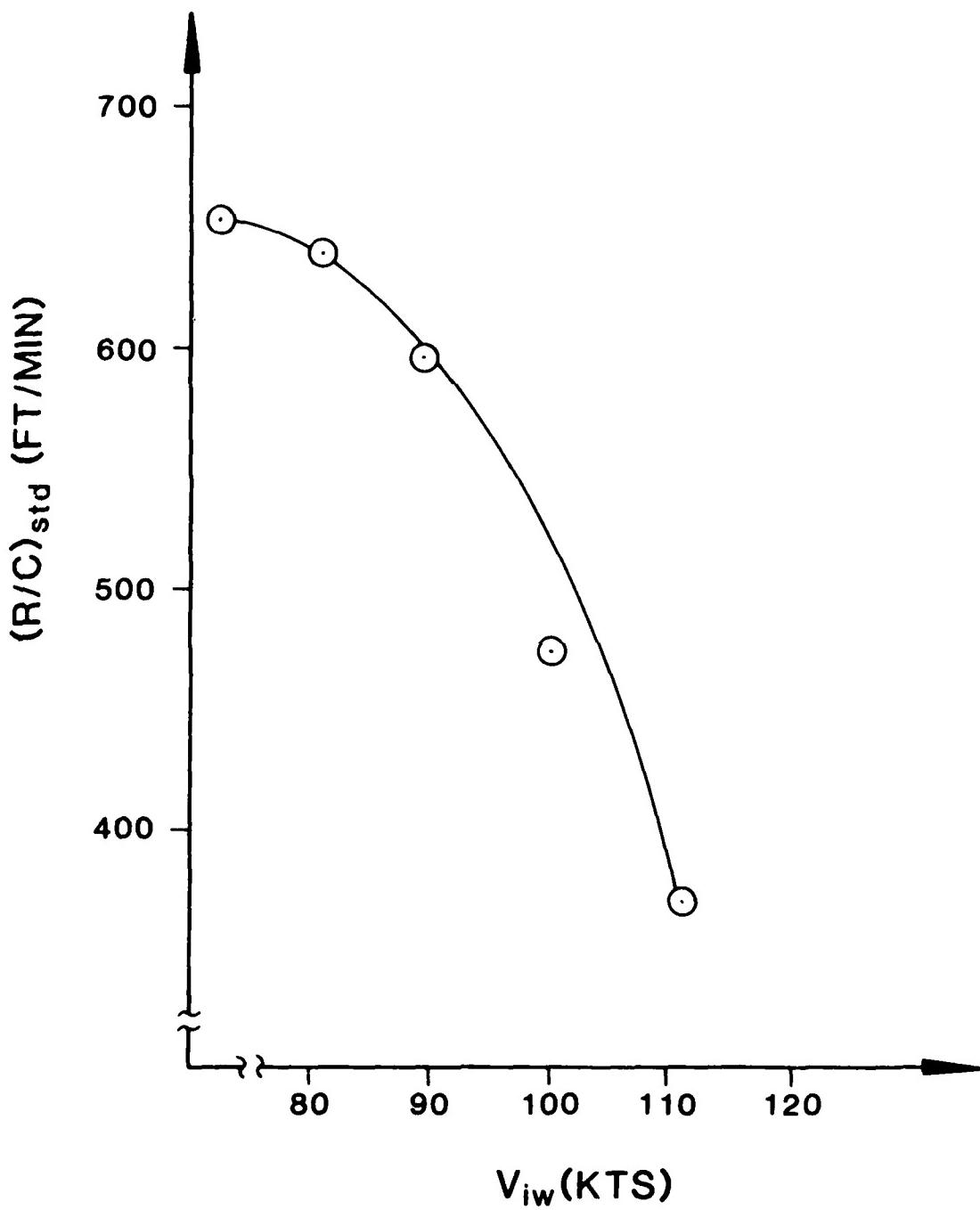
Beechcraft Sierra N18892

21 Feb'83

$H_{std} = \text{Sea Level}$

$W_{std} = 2750 \text{ lbs}$

Sawtooth Climbs





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1.  $V_i$  (Kts.) indicated airspeed
  2.  $V_c$  (Kts.)  $\approx V_e$  (Kts.), p. 5-10 F.M.
  3.  $H_i$  (ft.) indicated pressure altitude
  4.  $H_c$  (ft.) calibrated pressure altitude, p. 5-12 F.M.
  5. Test Weight,  $W_t$  = Basic Empty Weight + crew + fuel
  6.  $V_{iw} = V_e \left( \frac{W_s}{W_t} \right)^{\frac{1}{2}} = \textcircled{7} \times \left( \frac{W_s}{\textcircled{5}} \right)^{\frac{1}{2}}$
  7. Plot  $H_c$  versus time. Draw a tangent to the curve at test altitude. Slope is  $\left( \frac{dH}{dt} \right)_t$
  8.  $T_t$  = Absolute Test Temperature at test altitude  
 $T_t = \frac{\text{Absolute Test Temperature}}{\text{Absolute Std. Temperature}} \times 1.689^{\circ}\text{S}$
  9. Density Correction to Rate of Descent  
 $\left( \frac{dH}{dt} \right)_d = \left( \frac{dH}{dt} \right)_t \sqrt{\frac{T_t}{T_s}} = \textcircled{7} \times \sqrt{\textcircled{8}}$
  10. Weight Correction to Rate of Descent  
 $\left( \frac{dH}{dt} \right)_{STD} = \left( \frac{dH}{dt} \right)_d \sqrt{\frac{W_s}{W_t}} \quad 60 = \textcircled{9} \times \sqrt{\frac{W_s}{\textcircled{5}}} \times 60 \text{ (F.M.)}$
  11.  $\delta$ , pressure ratio from altitude charts for  $H_c$
  12.  $\sigma$ , density ratio =  $\frac{\delta}{T_t - \frac{\delta}{288.15}} = \frac{\textcircled{11} \times 288.15}{T_t - \frac{\textcircled{11} \times 288.15}{\textcircled{11} \times 288.15}}$
  13.  $V_{true}(Kts) = \frac{V_e}{\sigma} = \textcircled{2} \div (\textcircled{12})$
  14.  $C_L = \frac{1}{2} \rho_0 (V_e \times 1.689)^2 S = \frac{1}{2} \rho_0 (\textcircled{2} \times 1.689)^2 S$  ⑤

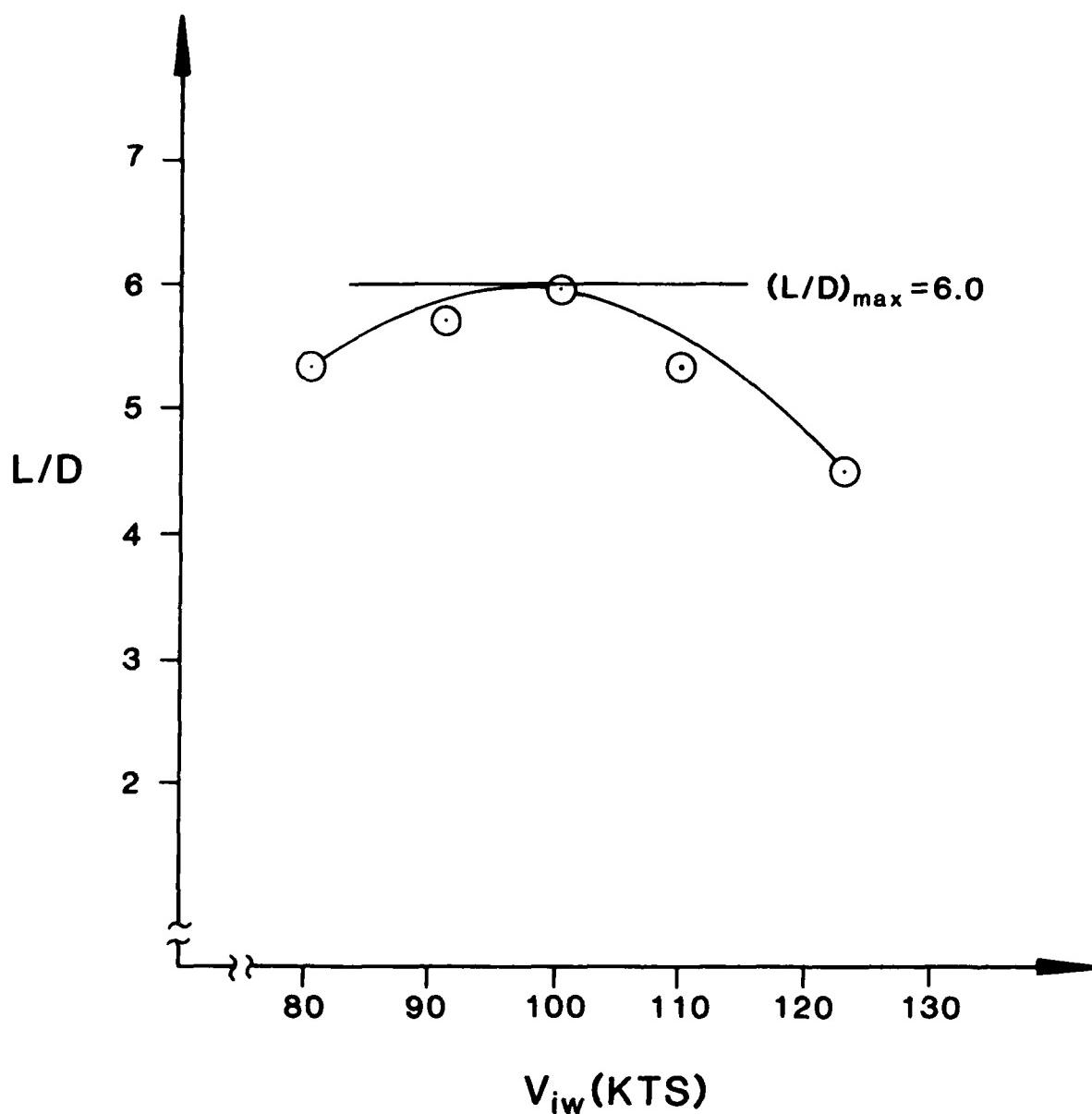
SPHERICAL PERIODICITY OF AIA RINGLET SYSTEMS

$$\text{Eq. } \frac{d\theta}{dt} = \frac{(dH/dt)_{\text{eff}} - \text{Rate}}{\text{Rate}_0 (V_e \times 1.589)^2}$$

$$\text{Eq. } \frac{d\theta}{dt} = \frac{(dH/dt)_{\text{eff}} - \text{Rate}}{\text{Rate}_0 (V_e \times 1.589)^2}$$

Beechcraft Sierra N18892

21 Feb'83 Throttle Idle and  
Prop at High Pitch  
Sawtooth Descents



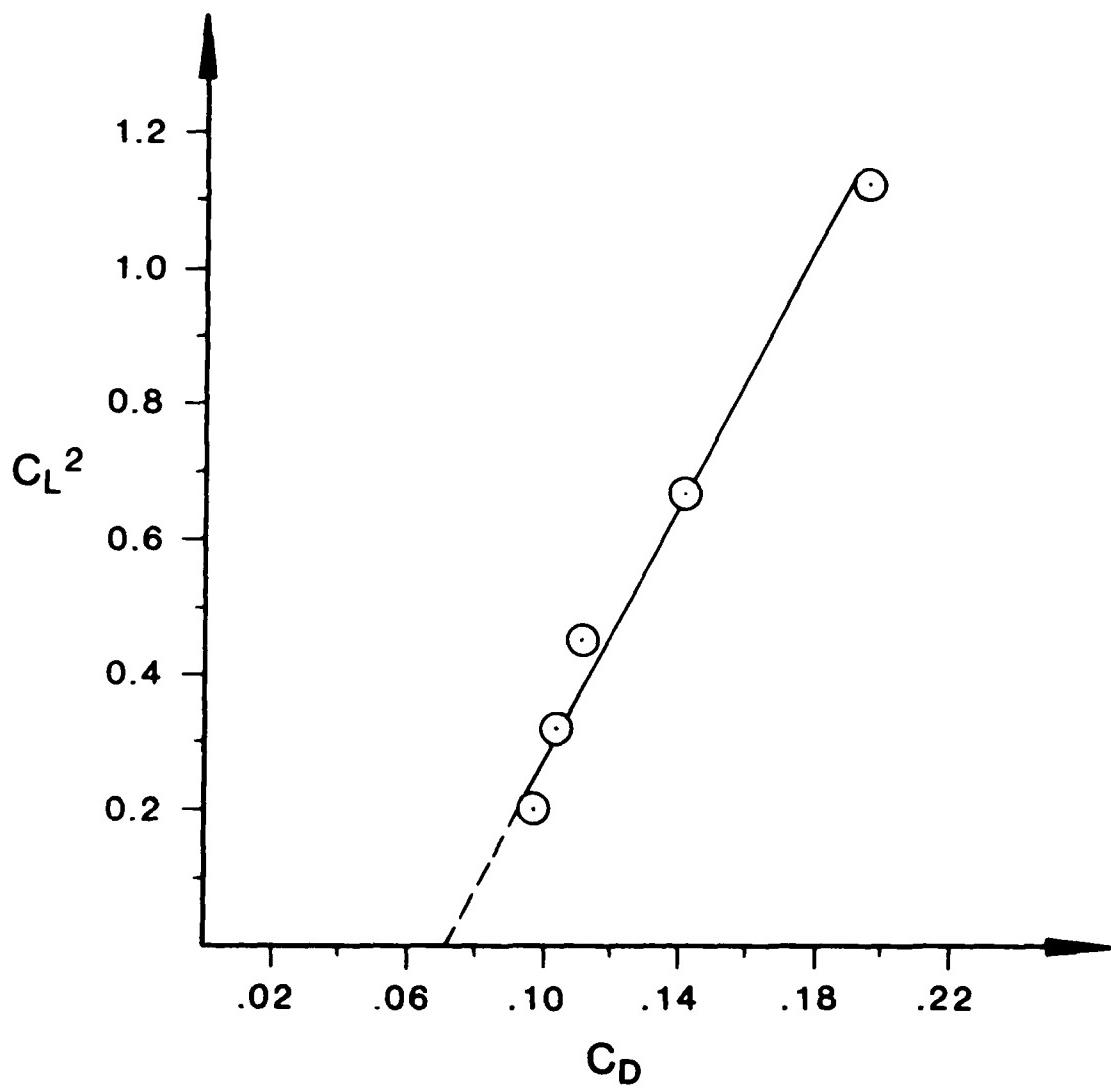
Beechcraft Sierra N18892

21 Feb'83       $C_D = .07 + .10C_L^2$

Throttle Idle and Prop at

High Pitch

Sawtooth Descents

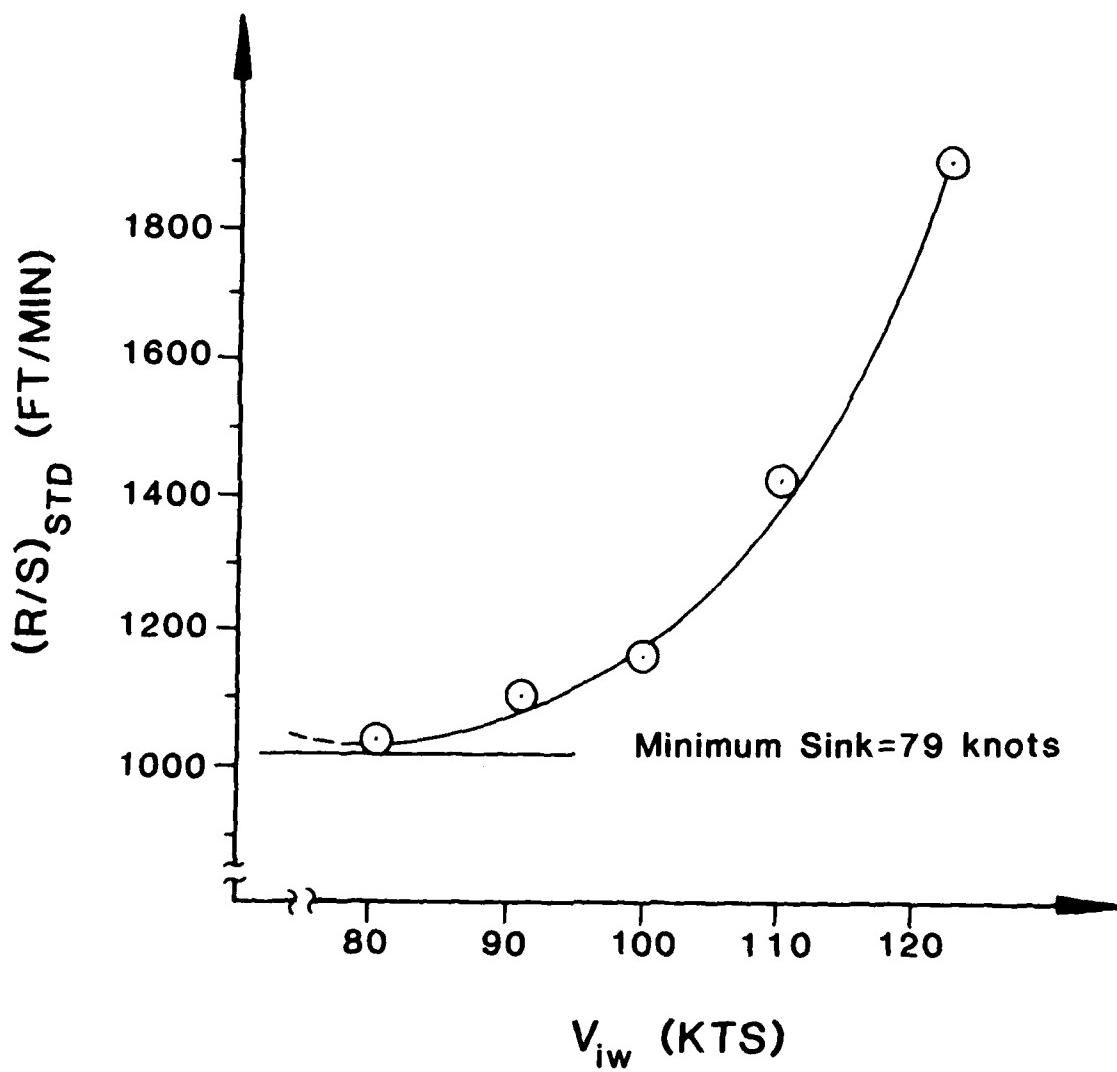


Beechcraft Sierra N18892

21 Feb'83

$W_{STD} = 2750$  pounds

Sea Level  
Throttle Idle and Prop at High Pitch  
Sawtooth Descents



## **APPENDIX E**

### **Test Plan**

### **Sundowner 180 C23 Limited Flying Qualities Evaluation**

UNITED STATES AIR FORCE ACADEMY

COLORADO 80840

DEPARTMENT OF AERONAUTICS

AERO 495

TEST PLAN

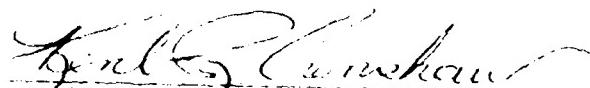
SUNDOWNER 180 C23 LIMITED FLYING QUALITIES EVALUATION

AUGUST 1982

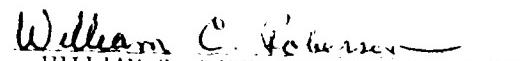
E-2

TEST PLAN  
DEPARTMENT OF AERONAUTICS  
SUNDOWNER 180 C23 LIMITED FLYING QUALITIES EVALUATION  
AUGUST 1982

This test plan has been prepared by:

  
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Aero 495 Course Director  
Department of Aeronautics

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Reviewed by:

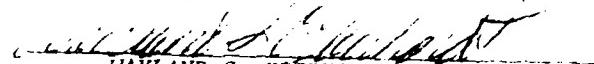
  
WAYLAND S. EBERHARDT  
Director of Flight Operation  
Hedrick Beechcraft Inc.

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TEST PLAN  
DEPARTMENT OF AERONAUTICS  
SUNDOWNER 180 C23 LIMITED FLYING QUALITIES EVALAUTION

INTRODUCTION

A limited flying qualities evaluation of the Beech Sundowner 180 C23 will be conducted by U. S. Air Force Academy, Department of Aeronautics (DFAN) faculty pilots and students enrolled in Aero 495. Flight testing will be conducted during the Fall 1982 semester from the 13th to 18th week of classes. Results of the evaluation will be presented in a formal oral report given by each of two student test teams.

OBJECTIVES

The primary objective of this test program is to provide the cadets with practical experience in flying qualities testing. They will qualitatively and quantitatively evaluate the Beech Sundowner 180 C23 as a primary trainer for Class I. The aircraft will be tested for compliance with MIL-F-8785C, Flying Qualities of Piloted Airplanes. Only those paragraphs of MIL-F-8785C listed under the Test Description/Procedures section of this test plan will be used in evaluating the Sundowner.

AUTHORITY

This test program will be conducted by Department of Aeronautics faculty and students as a part of the curriculum for Aero 495, a course in flight test techniques. The program has the approval of the Superintendent, the Dean of the Faculty, the Head of the Department of Aeronautics, and the Director of Flight Operation of Hedrick Beechcraft Inc.

TEST TEAM ORGANIZATION

Test team organization shown in Figure 1 will consist of two DFAN faculty pilots and two student flight test engineer teams. Each test team will be assigned to fly with one faculty pilot. A Test Director for each team will be appointed to coordinate the evaluation effort. He will appoint individuals to be in charge of each test area (i.e., data monitors). It will be the data monitor's responsibility to specify the test to be flown in support of his test area. Test areas to be assigned are weight and balance; longitudinal static stability and control; maneuvering flight; lateral-directional stability and control; dynamic stability; and high angle of attack (AOA) flying qualities.

DEPARTMENT OF AERONAUTICS  
PROFESSOR AND HEAD  
COL DALEY

AERO 495  
COURSE DIRECTOR  
MAJ CRENSHAW

OPERATIONS  
HEDRICK BEECHCRAFT  
MR. EBERHARDT

COURSE PILOTS  
MAJ CRENSHAW  
CAPT ROBERSON

TEST DIRECTOR  
TEAM A  
PROJECT ENGINEERS

TEST DIRECTOR  
TEAM B  
PROJECT ENGINEERS

Figure 1. Organization Chart

## SCOPE/SCHEDULE

The evaluation will consist of sorties as specified in Table I.

Table I. Data Sorties

| <u>Test</u>  | <u>Sorties<br/>Per Test Team</u> | <u>Flight Time<br/>Per Sortie</u> |
|--|----------------------------------|-----------------------------------|
| • Flight #3<br>Longitudinal and Lateral-<br>Directional Stability and<br>Control; Maneuvering Flight | 2.5                              | 1.0                               |
| • Flight #4<br>Dynamic Stability; Stalls   | 2.5                              | 1.0                               |
| *Total   | 5.0                              | —                                 |

\*One sortie will be shared by both test teams. Flight #3 and #4 are scheduled as shown on the Integrated Academics and Flying Schedule for Aero 495. Mission time will not exceed 1.0 hour.

## LIMITATIONS

The following limitations will be observed during this evaluation.

- A. The aircraft will be operated in the normal category in accordance with the Airplane Flight Manual, FAR Part 91 and all Beech Aero Club Operating Instructions.
- B. All data sorties will be flown with one DFAN faculty pilot and two cadets.
- C. Testing will only be accomplished under VFR daytime conditions at 10,000 feet MSL and below.
- D. All testing will be accomplished within the local flying area of Colorado Springs.

## TEST AIRCRAFT DESCRIPTION

The Beechcraft Sundowner 180 C23, manufactured by Beech Aircraft Corporation, is a four-place, fixed gear, general aviation aircraft powered by one 4-cylinder, 180 HP Avco Lycoming engine. The propeller is a Sensenich fixed pitch, two-blade prop with spinner. See Figure 2 for general dimensions and Table II for Aircraft Limitations.

BEECHCRAFT Sundowner 180  
C23 (M-1285 and After)

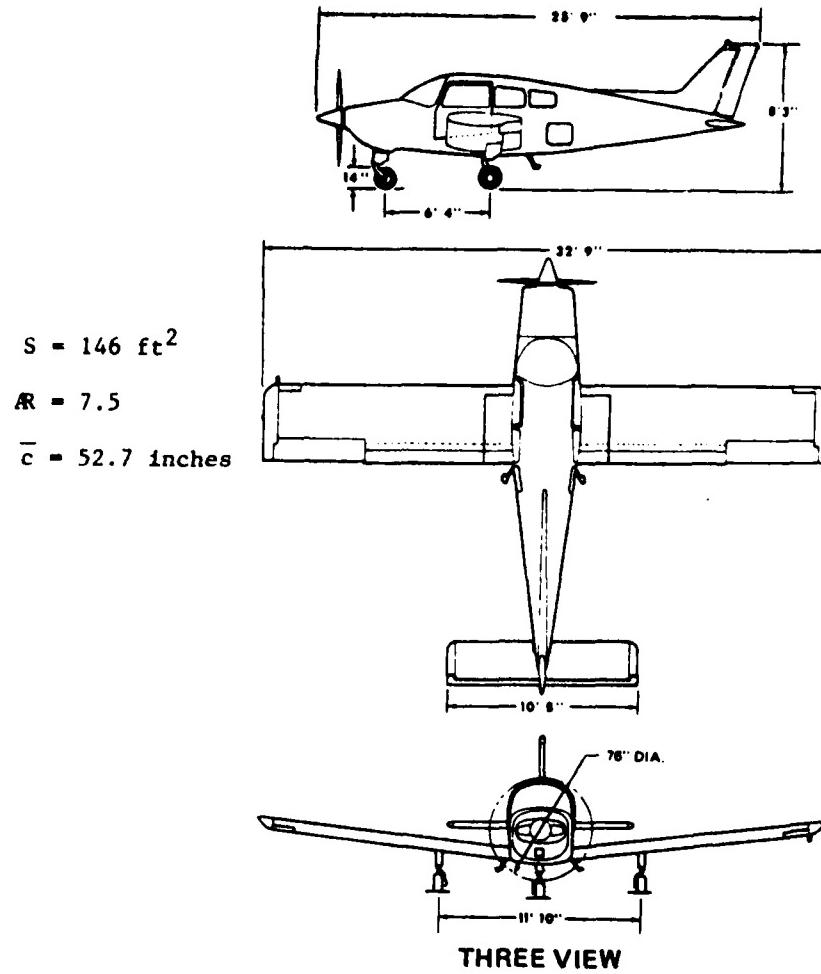


Figure 2. Three View of Sundowner 180 C23  
(Reference 1)

Table II. Aircraft Limitations

|  | <u>IAS</u><br><u>Knots/mph</u> |
|--|--------------------------------|
| Never Exceed Speed ( $V_{NE}$ )                      | 152/175                        |
| Maximum Maneuvering Speed ( $V_A$ )                  | 118/136                        |
| Maximum Cruising Speed in Turbulent Air ( $V_C$ )    | 136/156                        |
| 1G Stall Speed, Flaps Up (2,450 lbs)<br>(power idle) | 63/ 72                         |
| Maximum Ramp Weight                                  | 2,455 lbs                      |
| Maximum Takeoff and Landing Weight                   | 2,450 lbs                      |
| Flight Maneuvering Load Factor:                      |                                |
| Flaps Up   | +3.8 to -1.9G                  |
| Flaps Down   | +1.9G                          |
| Maneuver Bank Angles No More Than 60°                |                                |
| Sideslips are restricted to 30 seconds duration      |                                |
| Service Ceiling                                      | 12,600 feet                    |
| Test Plan Ceiling                                    | 10,000 feet                    |

#### FLIGHT TEST INSTRUMENTATION

Test data will be hand recorded using standard cockpit instrumentation, a mechanical force gage for elevator forces, a six volt electric strain gage device for rudder pedal forces, an accelerometer, and a stopwatch. As an option, a cassette tape player may be used to record data.

#### WEIGHT AND BALANCE

Detailed weight and balance records for each aircraft are available at Hedrick Beechcraft and will be reproduced in a handout for student use. Prior to every data mission, student test engineers will calculate aircraft weight and balance data for both takeoff and landing. Each test team will evaluate the longitudinal and maneuvering flying qualities of the Sundowner in both a forward and aft center of gravity (c.g.) condition. The only approved means of c.g. control will be in passenger seating, i.e., heaviest cadet either in front or back seat. Under no circumstances will the aircraft be operated outside the Flight Manual forward and aft c.g. limits.

#### TEST DESCRIPTION/PROCEDURES

##### A. General

All flying qualities tests will be performed with the engine operating and the wing flaps retracted. All data will be hand and/or voice recorded; and, as required, manually reduced to standard conditions.

## B. Longitudinal Static Stability and Control

1. The aircraft will be evaluated against the following paragraphs of reference 2 at the test points in Table III.

### 3.2.1.1 Longitudinal Static Stability

### 3.2.3.1 Longitudinal Control in Unaccelerated Flight

2. (3.2.1.1) The test will be accomplished using one of the methods described in reference 3. The airspeed will be varied over a range of  $\pm 15$  percent of the trim speed. The altitude will be maintained within  $\pm 1,000$  feet of the test altitude.

3. Using data from both aft and forward c.g. locations, the stick-free and stick-fixed neutral points will be determined using the procedure in reference 3.

## C. Maneuvering Flight

1. The aircraft will be evaluated against the following paragraphs of reference 2 at the test points in Table III.

### 3.2.2.2 Control Feel and Stability in Maneuvering Flight

### 3.2.2.2.1 Control Forces in Maneuvering Flight

### 3.2.2.2.2 Control Motions in Maneuvering Flight

### 3.2.3.2 Longitudinal Control in Maneuvering Flight

2. (3.2.2.2, 3.2.2.2.1, 3.2.2.2.2) Data for evaluating the aircraft against these paragraphs will be obtained using one of the methods described in reference 3. Altitude will be maintained within  $\pm 1,000$  feet of the trim altitude. "G" will be relaxed during rollout to avoid excessive asymmetric "G" loads on the aircraft.

3. Data from both aft and forward c.g. tests will be used to determine the stick-free and stick-fixed maneuver points in accordance with the procedure outlined in reference 3.

Table III. Static and Dynamic  
Stability and Control Test Points

| *Test Point<br>Nu | Pressure<br>Altitude (feet) | Trim<br>Airspeed (KIAS) |
|-------------------|-----------------------------|-------------------------|
| 1                 | 8,000                       | 80                      |
| 2                 | 8,000                       | 90                      |
| 3                 | 9,000                       | 80                      |
| 4                 | 9,000                       | 90                      |

\*Accomplish each test point at both forward and aft c.g. for longitudinal and maneuvering flight tests.

#### D. Lateral-Directional Stability and Control

1. The aircraft will be evaluated against the following paragraphs of reference 2 at the test points in Table III.

- 3.3.4 Roll Control Effectiveness
- 3.3.4.4 Linearity of Roll Response
- 3.3.4.5 Wheel Control Throw
- 3.3.2.5 Control of Sideslip in Rolls
- 3.3.2.6 Turn Coordination
- 3.2.3.7 Longitudinal Control in Sideslip
- 3.3.5 Directional Control Characteristics
- 3.3.6.1 Yawing Moments in Steady Sideslips
- 3.3.6.2 Side Forces in Steady Sideslips
- 3.3.6.3 Rolling Moments in Steady Sideslips

2. (3.3.2.6) This test will be accomplished by first trimming the aircraft in wings-level flight at the desired test point. Then a coordinated 45° bank turn will be established at the trim airspeed.

3. (3.2.3.7, 3.3.5, 3.3.6.1, 3.3.6.2, 3.3.6.3) Testing in these areas will be accomplished using the techniques described in reference 3.

4. Altitude for all tests will be maintained within  $\pm$  1,000 feet of the trim altitude.

5. Maximum sideslip duration will not exceed 30 seconds.

#### E. Dynamic Stability

1. The aircraft will be evaluated for compliance with the following paragraphs of reference 2.

- 3.2.1.2 Phugoid Stability
- 3.2.2.1 Short-Period Response
- 3.3.1.1 Lateral-Directional Oscillations (Dutch Roll)
- 3.3.1.2 Roll Mode
- 3.3.1.3 Spiral Stability

2. These tests will be accomplished at the points listed in Table III using the test methods specified in reference 3.

3. (3.3.1.1) The Dutch Roll will be excited using ramp rudder inputs applied smoothly to  $\frac{1}{2}$  deflection either side of neutral. Sharp or rapid rudder inputs, which impose high loads on the aircraft structure, will not be used to excite the Dutch Roll.

4. (3.3.1.2) The aircraft will be trimmed initially for wings-level flight at the desired test point. From a coordinated 45° bank turn at the trim airspeed, roll performance will be tested by rolling the aircraft with a step aileron input to the same bank angle in the other direction. Roll performance will be measured at  $\frac{1}{2}$  and full control wheel deflections.

#### F. High AOA Tests

1. The aircraft will be tested for compliance with the following paragraphs of reference 2 and at the test points shown on Table IV.

Table IV. High AOA Test Points

| <u>Test Point<br/>Nu</u> | <u>Pressure<br/>Altitude (feet)</u> | <u>*Trim<br/>Airspeed (KIAS)</u> |
|--------------------------|-------------------------------------|----------------------------------|
| 5                        | 9,000                               | 1.2 $V_s$                        |
| 6                        | 10,000                              | 1.2 $V_s$                        |

\*For the purpose of determining trim airspeed,  $V_s$  will be the wings level, flaps up, power off stall speed of 72 mph/ 63 KIAS.

- 3.4.2 Flight at High Angle of Attack
- 3.4.2.1 Stalls
- 3.4.2.1.1 Stall Approach
- 3.4.2.1.1.1 Warning Speed for Stalls at 1g Normal to the Flight Path
- 3.4.2.1.2 Stall Characteristics
- 3.4.2.1.3 Stall Prevention and Recovery

2. The aircraft will be tested only during Phase A stalls as defined in reference 4. Emphasis during the test program will be placed on determining the adequacy of the aircraft controls during the approach to the stall and during stall recovery; the adequacy and nature of the stall warning characteristics; and the stall recovery techniques. The aircraft will not be flown into a deep stall. Recovery will be initiated when (see Table I, reference 4):
  - a. a definite g-break occurs.
  - b. a rapid, uncommanded angular motion develops.
  - c. the aft stick stop has been reached and pitch attitude cannot be increased.
  - d. sustained heavy buffet develops.

3. The aircraft will be trimmed for 1g flight at the airspeed and altitudes specified in Table IV. Using the test methods in reference 3, the aircraft will then be maneuvered so that the stall occurs at the test altitude ( $\pm 500$  feet).

4. Stall recovery will be initiated at the onset of the first stall.

5. Stalls will be accomplished at 8,500 feet MSL minimum.

#### TRAINING

Both DFAN faculty pilots will have at least an FAA commercial pilot rating and be current in the Beech Sundowner 180 C23 in accordance with FAA and Hedrick Beechcraft Aero Club standards.

All cadets enrolled in Aero 495 will participate in the flying portion of the course as passengers only and will receive appropriate aircraft orientation and safety instruction. All the performance flight test techniques required to gather test data will be covered during classroom lectures prior to the flights for which they will be used.

CREW DUTIES

A. Pilot

1. Check local flying weather.
2. Brief students on mission profile, and ground and in-flight safety.
3. Check maintenance status of aircraft and perform pre-flight.
4. Provide a stopwatch.
5. Provide the tachometer reading at which the aircraft was refueled and the quantity of fuel and oil on board.
6. Act as pilot in command of the aircraft and occupy the left front seat at all times.

B. Students

1. Bring data cards and a clipboard.
2. Complete aircraft weight and balance form.
3. Compute takeoff data using temperature and pressure altitude provided by the pilot.
4. Provide cassette tape player for each flight. (optional)
5. Record tachometer reading at which the aircraft was refueled and the quantity of fuel and oil on board.
6. Cadets will be assigned to two man teams for purposes of taking flight test data. Flight crew duties will be rotated each flight. Along with the pilot who will be primarily concerned with precisely flying the aircraft, both cadets will act as lookouts and notify the pilot immediately of any aircraft sighted. The cadet in the right front seat will act as data observer and timekeeper, and the cadet in the rear seat will act as data recorder.

SAFETY

Flight personnel will adhere to the following while on the flightline and in and around the aircraft:

- a. Smoking is prohibited in or near the aircraft.
- b. Seat belts will be worn at all times.
- c. Flight personnel will be seated in the aircraft prior to engine start and will remain seated until the engine is stopped.

- d. Remain clear of the propeller area at all times.
- e. Do not stand, walk, or lean on the aircraft except in designated areas.
- f. Do not open aircraft windows or doors in flight.
- g. Advise the pilot immediately upon observing another aircraft.
- h. Do not manipulate the aircraft flight controls or engine controls unless told to do so by the pilot.
- i. Advise the pilot of impending airsickness. Use the bag provided, your hat, your shoe, anything except the floor of the aircraft.
- j. Stay clear of taxiing aircraft and other flightline vehicles.

#### COMMAND AND CONTROL

All testing to be accomplished will be for academic purposes only and will be performed within the restrictions of the Flight Manual, Part 91 of the FAR's, Hedrick Beechcraft Aero Club Rules and the limitations imposed by this test plan.

All information with respect to this test plan is unclassified.

#### TEST PLAN AMENDMENTS

An amendment to this test plan is required if the flight test envelope is expanded or if any limitations in the test plan are made less restrictive. An amendment to the test plan must be reviewed and approved by the same authority who approved the basic plan.

REFERENCES

1. Pilot's Operating Handbook and FAA Approved Airplane Flight Manual for the Beechcraft Sundowner 180 C23, Beech Aircraft Corporation, Wichita, Kansas, August 1980.
2. Military Specification, Flying Qualities of Piloted Airplanes, Department of the Air Force, Washington, D.C., MIL-F-8785C, 5 November 1980.
3. Roberts, Sean C., Flying Qualities Flight Testing of Light Aircraft for Test Pilots and Flight Test Engineers, Flight Research, Inc., Mojave, California, September 1981.
4. Military Specifications, Stall/Post-Stall/Spin Flight Test Demonstration Requirements for Airplanes, Department of the Air Force, Washington, D.C., MIL-S-83691A (USAF), 15 April 1972.

## MEMORANDUM FOR THE RECORD

29 October 1982

Subject: Aero 495 Test Plan Revision for Sundowner 180 C23 Limited Flying Qualities Evaluation

To: Captain William C. Roberson William C. Roberson  
Aero 495 Course Pilot

Mr. Wayland S. Eberhardt  
Director of Flight Operation  
Hedrick Beechcraft, Inc.

1. The Test Plan for the Sundowner 180 C23 Limited Flying Qualities Evaluation dated August 1982 is revised. The second to the last sentence in the paragraph titled Weight and Balance on page 5 should read:

"The only approved means of aft c.g. control will be with the use of two 50 pound lead weights secured in the baggage area. Ballast will not be carried for forward c.g. control."

2. There may not be sufficient spread in center of gravity location by using passenger seating alone to get adequate forward and aft c.g. flying qualities data. Adding lead ballast to the baggage compartment, however, does enhance the importance of checking the weight and balance prior to flight.

3. The following table is provided to aid you in computing weight and balance with ballast on board:

| <u>REG NO.</u> | <u>BASIC EMPTY<br/>CONDITION +<br/>100 LBS BALLAST</u> | <u>MOM/100<br/>(in/lb<sub>f</sub>)</u> | <u>% c.g.<br/>SHIFT AFT</u> |
|----------------|--|--|-----------------------------|
| N6014M         | 1690.0 lbs   | 1945                                   | 2.7%                        |
| N60171         | 1625.0 lbs   | 1855                                   | 2.7%                        |
| N18325         | 1680.5 lbs   | 1959                                   | 2.8%                        |

*Kent R. Crenshaw*  
KENT R. CRENSHAW, Maj, USAF  
Aero 495 Course Director

## **APPENDIX F**

### **Flight Test Planing Guide Sundowner 180 C23 Limited Flying Qualities Evaluation**

AERO 495 FLIGHT TEST TECHNIQUES

FLIGHT TEST PLANNING GUIDE

REPRODUCED BY THE USAF COMPTIA

SUNDOWNER C23 LIMITED FLYING QUALITIES EVALUATION

MAJ CRENSHAW

FEBRUARY 1983

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## FLIGHT 3

### Longitudinal and Lateral-Directional Stability and Control; Maneuvering Flight

#### I. OBJECTIVES

- A. Measure the slope and linearity of the longitudinal stick force and elevator displacement curves.
- B. Determine the stick-fixed and stick-free neutral points.
- C. Determine the stick-fixed and stick-free maneuver points.
- D. Measure the slope and linearity of the rudder pedal force and displacement versus sideslip.
- E. Evaluate the turn coordination of the aircraft.

#### II. AIRCRAFT

Beechcraft Sundowner 180 C23

#### III. LIMITATIONS

As specified in the test plan.

#### IV. MISSION EVENTS

##### A. Pilot

1. Make a Flight Manual, no flap takeoff.
2. Stabilize the aircraft in level flight at a selected test altitude of either 8,000 or 9,000 feet.
3. Trim the aircraft for either 80 or 90 KIAS. Lean the engine for best cruise.
4. From the trim airspeed, use the stabilized test technique and vary airspeed  $\pm$  15%, staying within  $\pm$  1,000 feet of the test altitude.
5. From the trim airspeed, use the stabilized test technique and vary load factor up to and including  $\pm$  2.0 "g's" while descending to maintain constant airspeed. Stay within  $\pm$  1,000 feet of the test altitude. Perform the test in both directions.
6. Perform steady sideslips at various sideslip angles up to maximum sideslip in both directions. Maximum sideslip duration will not exceed 30 seconds.
7. Stabilize the aircraft in 45° bank turns in both directions at the trim airspeed and test altitude.
8. Make normal full stop landing.

B. Students

1. Compute take-off weight, center of gravity and predicted take-off roll.
2. Record the data required on the attached data sheets.
3. Record both pre-flight and post-flight aircraft tach time.

V. STUDENT POST-FLIGHT DATA REDUCTION

A. Reduce the data using the attached data reduction sheets.

B. Plot:

1. Stick deflection  $\delta_e$  and stick force  $F_e$  versus indicated airspeed  $V_1$  for longitudinal static stability test points.
2. Stick deflection  $\delta_e$  and  $F_e/q$  versus lift coefficient  $C_L$ .
3. Stick deflection  $\delta_e$  and stick force  $F_e$  versus load factor  $n$ .
4. Rudder deflection  $\delta_R$  and rudder force  $F_R$  versus sideslip angle  $\beta$ .
5. Bank angle  $\theta$ , aileron deflection  $\delta_a$  and stick force  $F_e$  versus  $\beta$ .

C. Using data from other flights (if available) with forward and aft centers of gravity, determine the following:

1. Stick-fixed and stick-free neutral points.
2. Stick-fixed and stick-free maneuver points.
3. Compare these points to the forward and aft center of gravity limits in the flight manual.

D. Evaluate the aircraft against the following paragraphs of MIL-F-8785C:

- 3.2.1.1 Longitudinal Static Stability
- 3.2.2.2 Control Feel and Stability in Maneuvering Flight
- 3.2.2.2.1 Control Forces in Maneuvering Flight
- 3.2.2.2.2 Control Motions in Maneuvering Flight
- 3.3.2.6 Turn Coordination
- 3.2.3.7 Longitudinal Control in Sideslip
- 3.3.6.1 Yawing Moments in Steady Sideslips
- 3.3.6.2 Side Forces in Steady Sideslips
- 3.3.6.3 Rolling Moments in Steady Sideslips

E. Complete the "Initial Flight Test Report".

F. Complete a set of sample calculations.

G. Turn in the "Initial Flight Test Report", MIL-F-8785C evaluation results, recorded data sheets, data reduction sheets, sample calculations and plots using the format specified in the "Guidelines for Flight Reports" handout.

FLIGHT 3 DATA RECORD

DATE \_\_\_\_\_ TAKEOFF DATE: FIELD ELEVATION - 6,172 FEET  
 INSTRUCTOR \_\_\_\_\_ ALTIMETER \_\_\_\_\_  
 STUDENT: OBSERVER - WINDS \_\_\_\_\_  
 RECORDER - PRESS. ALT. \_\_\_\_\_  
 AIRCRAFT NO. N- TEMP. \_\_\_\_\_  
 PRE-FLIGHT TACH TIME \_\_\_\_\_ GD ROLL (P) \_\_\_\_\_  
 REMARKS: FUEL \_\_\_\_\_ OIL \_\_\_\_\_  
 POST-FLIGHT TACH TIME \_\_\_\_\_

LONGITUDINAL STATIC STABILITY

| F-6 Trim Conditions: (RUN 1) |             |                           |                 | Trim Conditions: (RUN 2) |                 |                           |             | Trim Conditions: (Right Turn) |                       |           |           | MANEUVERING STABILITY |         |             |                           |                 |     |                 |                           |
|------------------------------|-------------|---------------------------|-----------------|--------------------------|-----------------|---------------------------|-------------|-------------------------------|-----------------------|-----------|-----------|-----------------------|---------|-------------|---------------------------|-----------------|-----|-----------------|---------------------------|
| $V_i$ (KTS)                  | $V_i$ (KTS) | $H_i$ (FT)                | $H_i$ (FT)      | $V_i$ (KTS)              | $V_i$ (KTS)     | $H_i$ (FT)                | $H_i$ (FT)  | $T_i$ ( $^{\circ}$ C)         | $T_i$ ( $^{\circ}$ C) | Tach Time | Tach Time | MAP/RPM               | MAP/RPM | $V_i$ (KTS) | $F_e$ (1lb <sub>f</sub> ) | $\delta_e$ (IN) | "g" | $\delta_e$ (IN) | $F_e$ (1lb <sub>f</sub> ) |
| $V_{trim}$                   | $V_{trim}$  | $F_e$ (1lb <sub>f</sub> ) | $V_{aim}$ (KTS) | $V_i$ (KTS)              | $\delta_e$ (IN) | $F_e$ (1lb <sub>f</sub> ) | $V_i$ (KTS) | $V_{trim}$                    | $V_{trim}$            |           |           |                       |         |             |                           |                 |     |                 |                           |
| $V_{trim}$                   |             |                           |                 |                          |                 |                           |             |                               |                       |           |           |                       |         |             |                           |                 |     |                 |                           |
| $V_{trim}$                   |             |                           |                 |                          |                 |                           |             |                               |                       |           |           |                       |         |             |                           |                 |     |                 |                           |

Remarks: \_\_\_\_\_

Remarks: \_\_\_\_\_

Remarks: \_\_\_\_\_

## FLIGHT 3 DATA RECORD

PAGE 2

## LATERAL-DIRECTIONAL STATIC STABILITY

| Trim Conditions:      |       | Remarks:                                   |             | Turn Coordination: $\theta = 45^\circ$ |               |               |               |                |       |               |               |               |               |                |
|-----------------------|-------|--|-------------|--|---------------|---------------|---------------|----------------|-------|---------------|---------------|---------------|---------------|----------------|
| $V_i$ (KTS)           | _____ | Right: $F_e$ (1bf) _____ $F_R$ (1bf) _____ |             |  |               |               |               |                |       |               |               |               |               |                |
| $H_i$ (FT)            | _____ | Left: $F_e$ (1bf) _____ $F_R$ (1bf) _____  |             |  |               |               |               |                |       |               |               |               |               |                |
| $T_i$ ( $^{\circ}$ C) | _____ | Remarks:                                   |             |  |               |               |               |                |       |               |               |               |               |                |
| $\delta_R$ (IN)       | _____ | $\beta_{aim}$                              | $\beta = 0$ | -2 $^{\circ}$                          | -4 $^{\circ}$ | -6 $^{\circ}$ | -8 $^{\circ}$ | -10 $^{\circ}$ | 0     | +2 $^{\circ}$ | +4 $^{\circ}$ | +6 $^{\circ}$ | +8 $^{\circ}$ | +10 $^{\circ}$ |
| Tach Time             | _____ | $\beta$ (deg)                              | _____       | _____                                  | _____         | _____         | _____         | _____          | _____ | _____         | _____         | _____         | _____         |                |
| MAP/RPM               | _____ | $\theta$ (deg)                             | _____       | _____                                  | _____         | _____         | _____         | _____          | _____ | _____         | _____         | _____         | _____         |                |
|                       |       | $\delta_R$ (in)                            | _____       | _____                                  | _____         | _____         | _____         | _____          | _____ | _____         | _____         | _____         | _____         |                |
|                       |       | * $\delta_a$ (left)                        | _____       | _____                                  | _____         | _____         | _____         | _____          | _____ | _____         | _____         | _____         | _____         |                |
|                       |       | * $\delta_a$ (right)                       | _____       | _____                                  | _____         | _____         | _____         | _____          | _____ | _____         | _____         | _____         | _____         |                |
|                       |       | $F_R$ (right)                              | _____       | _____                                  | _____         | _____         | _____         | _____          | _____ | _____         | _____         | _____         | _____         |                |
|                       |       | $F_R$ (left)                               | _____       | _____                                  | _____         | _____         | _____         | _____          | _____ | _____         | _____         | _____         | _____         |                |
|                       |       | $F_e$ (1bf)                                | _____       | _____                                  | _____         | _____         | _____         | _____          | _____ | _____         | _____         | _____         | _____         |                |

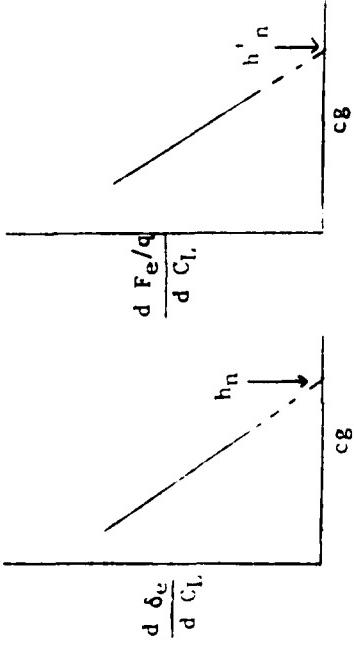
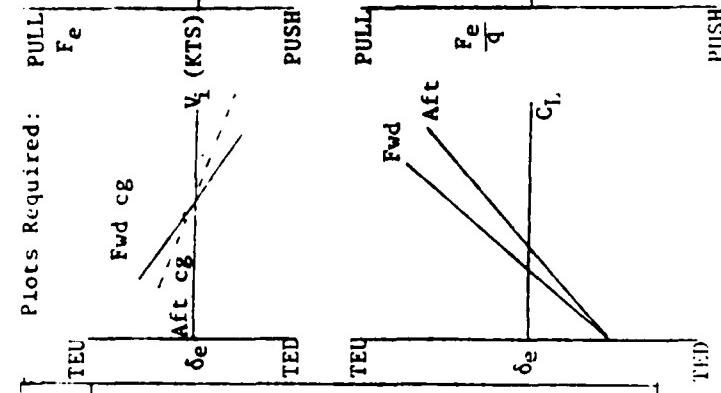
NOTE: Plot data as recorded. No data reduction required.  
 \* In case 1/8, 1/4, 1/2 deflection, etc.

LONGITUDINAL STATIC STABILITY DATA REDUCTION:

REF ID: A3210000000000000000000000000000

Aircraft, Sundowner 180 C23      Wing Area:  $S = 146 \text{ ft}^2$

| $V_i$ (KTS) | $V_e$ (KTS) | $q$ | $C_L$ | $\delta_e$ (inches) | $F_e$ (lb) | $F_e/q$ |
|-------------|-------------|-----|-------|---------------------|------------|---------|
| 1           |             |     |       |                     |            |         |
| 2           |             |     |       |                     |            |         |
| 3           |             |     |       |                     |            |         |
| 4           |             |     |       |                     |            |         |
| 5           |             |     |       |                     |            |         |
| 6           |             |     |       |                     |            |         |
| 7           |             |     |       |                     |            |         |

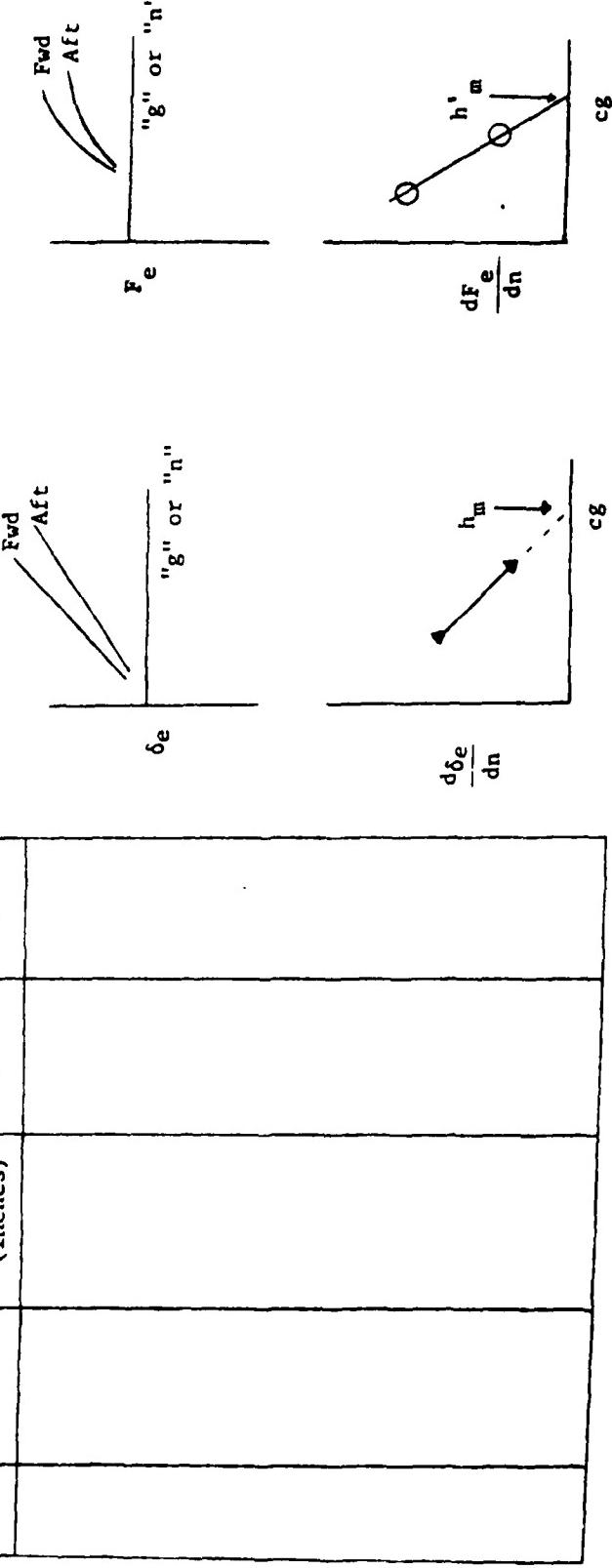


1.  $V_i$  (KTS) indicated airspeed.
2.  $V_e$  (KTS)  $\approx V_i$  (KTS) equivalent airspeed, p. 5-10 F.M.
3.  $q = \frac{1}{2}\rho_0 V_e^2 = \frac{0.002377}{2} (2) \times 1.69)^2$
4.  $C_L = \frac{W}{\frac{1}{2}\rho_0 V_e^2} S = \frac{W}{qS} = \frac{W}{\textcircled{3} S}$
5.  $\delta_e$  (inches) Stick displacement in inches
6.  $F_e$  (lb) Elevator force in pounds.
7.  $F_e/q = \frac{\textcircled{6}}{\textcircled{4}}$

LONGITUDINAL MANEUVERING STABILITY DATA REDUCTION

Aircraft, Sundowner 180 C23

| c.g. | $V_i$ (kts) | $\delta_e$<br>(inches) | $F_e$ (1b) | "g" |
|------|-------------|------------------------|------------|-----|
|      |             |                        |            |     |

Wing Area:  $S = 146 \text{ ft}^2$ 

1. Cg in % MAC.

2.  $V_i$  indicated airspeed.3.  $\delta_e$  (in) Stick displacement in inches4.  $F_e$  (1b) Elevator forces in lb.

5. "g" direct reading off gauge.

Stick-fixed maneuvering

Stick-free maneuvering

FLIGHT 4

DYNAMIC STABILITY; STALLS

I. OBJECTIVES

- A. Determine the lateral control power of the aircraft.
- B. Measure the short period, phugoid, Dutch roll and spiral characteristics of the aircraft.
- C. Observe the aircraft stall characteristics to include stall warning and verify the  $l_g$  stall speeds given in the Flight Manual.

II. AIRCRAFT

Beechcraft Sundowner 180 C23

III. LIMITATIONS

As specified in the test plan.

IV. MISSION EVENTS

A. Pilot

1. Make a no flap, Flight Manual takeoff.
2. Stabilize the aircraft in level flight at a selected altitude and trim airspeed for the first tests to be performed.
3. For stalls, trim the aircraft for  $1.2 V_g$  at a minimum altitude of 8,500 ft MSL. Using the curved flight path method, leave the throttle at the trim setting and use pitch to achieve a bleed rate of 1 to 2 knots per second. The aircraft should stall within  $\pm 500$  feet of the desired stall altitude. Initiate recovery when:
  - a. a definite g-break occurs.
  - b. a rapid, uncommanded angular motion develops.
  - c. the aft stick stop has been reached and pitch attitude cannot be increased.
  - d. sustained heavy buffet develops.
4. Stabilize the aircraft in level flight at one selected altitude and trim airspeed for all remaining tests.
5. For the lateral control power evaluation, perform aileron rolls from  $45^\circ$  to  $45^\circ$  of bank with  $\frac{1}{2}$  and full control wheel deflection. This test should be done in both directions with the rudder fixed.
6. For the dynamic tests, use the following techniques:

- a. Short Period - Pump the elevator using sinusoidal ramp inputs of  $\pm .5 "g"$  until the aircraft response is in phase with the elevator input. Release the control wheel at the trim position. Use small rudder inputs to maintain wings level.
- b. Phugoid - From the trim condition, perturb the airspeed by 15 knots and return the control wheel back to the trim position and release. Again, use small rudder inputs to maintain wings level.
- c. Dutch Roll - From the trim condition, perturb the aircraft using sinusoidal ramp inputs of  $\frac{1}{4}$  rudder deflection, then return the rudder to neutral and release.
- d. Spiral - Stabilize the aircraft in a coordinated left or right turn at a  $20^\circ$  bank angle. Neutralize the aileron control and release. Perform the test in both directions. Time for 20 seconds.

B. Students

1. Compute take-off weight, center of gravity and predicted takeoff ground roll.
2. Record the information shown on the attached data record sheets for each test performed.
3. Record both pre-flight and post-flight each time.

V. STUDENT POST-FLIGHT DATA REDUCTION

A. Reduce data where required using the attached data reduction sheets. Use a standard weight of 2,450 lbs for analyzing stall speeds.

B. Plot

1.  $\theta$  versus time.
2.  $V_1$  versus time for the phugoid dynamic mode.

C. Using the plots above where appropriate and other test data, determine the following:

1. 1 "g" indicated stall speed for a standard weight of 2,450 lb<sub>f</sub> and compare with the Flight Manual.
2. For the phugoid dynamic mode, determine the period, T, the damping ratio,  $\xi$ , time to half amplitude,  $t_{\frac{1}{2}}$ , actual frequency,  $\omega_D$ , and the undamped natural frequency,  $\omega_n$ . Use the log decrement method with your plotted data. Compare your flight test,  $\omega_n$ , with the approximation equation for  $\omega_n$ .
3. Report the time to double,  $t_2$ , or time to half,  $t_{\frac{1}{2}}$ , bank angle for the spiral dynamic mode.

4. Determine the period, T, actual frequency,  $\omega_D$ , estimate the damping and find the undamped natural frequency of the Dutch Roll oscillation.

5. Report the time to roll through 60° of bank. Find the roll mode time constant.

D. Evaluate the aircraft against the following paragraphs of MIL-F-8785C:

1. Dynamic Stability:

- 3.2.1.2 Phugoid Stability
- 3.2.2.1 Short Period Response
- 3.3.1.1 Lateral-Directional Oscillations (Dutch Roll)
- 3.3.1.2 Roll Mode
- 3.3.1.3 Spiral Stability
- 3.3.4 Roll Control Effectiveness
- 3.3.4.5 Wheel Control Throw
- 3.3.2.5 Control of Sideslip in Rolls

2. High AOA Tests:

- 3.4.2.1.1 Stalls Approach
- 3.4.2.1.1.1 Warning Speed for Stalls at 1g Normal to the Flight Path
- 3.4.2.1.2 Stall Characteristics
- 3.4.2.1.3 Stall Prevention and Recovery

E. Complete the "Initial Flight Test Report".

F. Complete a set of sample calculations.

G. Turn in the "Initial Flight Test Report", MIL-F-8785C evaluation results, recorded data sheets, data reduction sheets, sample calculations, and plots using the format specified in the "Guidelines for Flight Reports" handout.



## AIRCRAFT DYNAMICS

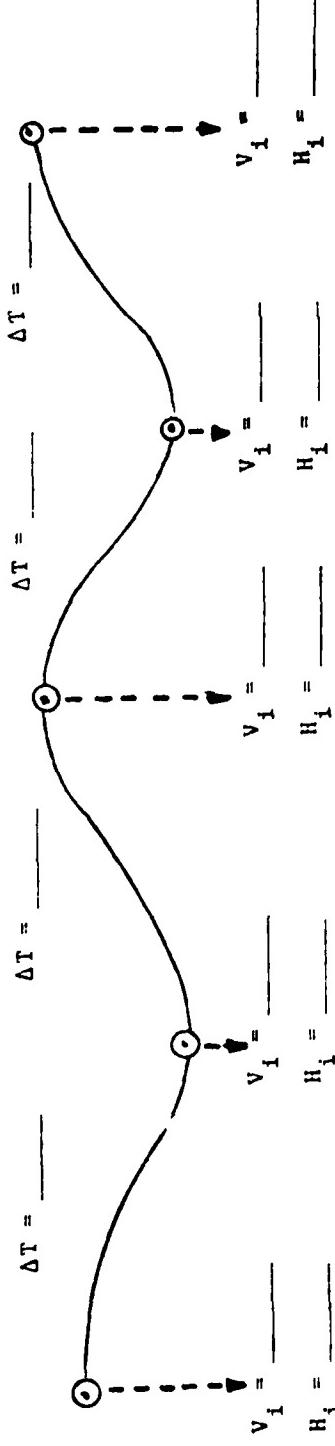
Trim Conditions:  $V_i$  (KTS) \_\_\_\_\_  $H_i$  (FT) \_\_\_\_\_  $T_i$  ( $^{\circ}$ C) \_\_\_\_\_  
 Tach Time \_\_\_\_\_ MAP/RPM \_\_\_\_\_

Short Period

Damping \_\_\_\_\_  
 Remarks:

0/S \_\_\_\_\_ Time \_\_\_\_\_

Phugoid



Remarks: Record  $V_i$  and  $H_i$  each time  $V_i$  passes zero.

Dutch Roll Damping \_\_\_\_\_ 0/S \_\_\_\_\_ Time \_\_\_\_\_

$\phi/\beta$  \_\_\_\_\_

Remarks:

Spiral (Left) \_\_\_\_\_  ${}^{\circ}\phi$  \_\_\_\_\_  $t_o$  \_\_\_\_\_  ${}^{\circ}\phi$  \_\_\_\_\_  $t_o$  \_\_\_\_\_  ${}^{\circ}\phi$  \_\_\_\_\_  
 (Right) \_\_\_\_\_  ${}^{\circ}\phi$  \_\_\_\_\_  $t_o$  \_\_\_\_\_  ${}^{\circ}\phi$  \_\_\_\_\_  $t_o$  \_\_\_\_\_  ${}^{\circ}\phi$  \_\_\_\_\_

Remarks:

Lateral Control Power Data Reduction

Aircraft, Sundowner 180 C23

$$\text{Wine Area} = 146 \text{ ft}^2$$

**Use tape recorder to get these.** Recommend in-flight handwritten record as a backup.

1.  $\delta_a$  (R) Right aileron deflection
  2.  $\delta_a$  (L) Left aileron deflection
  3. Successive time to roll  $\Delta\theta = 90^\circ$  to the left
  4. Successive time to roll  $\Delta\theta = 90^\circ$  to the right
  5. Successive bank angle  $\theta$  to the left
  6. Successive bank angle  $\theta$  to the right
  7. Plot  $\theta$  versus  $t$  for both left and right turn for each  $\delta_a$  tested

STALL TESTING DATA REDUCTION

| ① | $H_{pi}$ | $v_i$ | $v_e$ | $w_t$ | $c_L$ | $v_{tw}$ |
|---|----------|-------|-------|-------|-------|----------|
| ② |          |       |       |       |       |          |
| ③ |          |       |       |       |       |          |
| ④ |          |       |       |       |       |          |
| ⑤ |          |       |       |       |       |          |
| ⑥ |          |       |       |       |       |          |

- $H_{pi}$  (ft) Indicated pressure altitude
  - $V_i$  (Kts) Indicated airspeed
  - $V_c$  (Kts)  $\approx V_e$  (Kts) Equivalent airspeed; P. 5-10 F.M.
  - $W_t$  (lbs) Aircraft test weight: empty weight + fuel + people
  - $C_L = \frac{2W}{\rho V^2 S} = \frac{2 \times \textcircled{4}}{.002377 (\textcircled{3}) \times 1.689^2 S}$   
where S is wing area.
  - Calculate  $C_L$  for each speed
  - $V_{iw} = \textcircled{3} \sqrt{\frac{W_s}{\textcircled{4}}}$   
( $W_s = 2,450$  lbs)

NOTE: Do this for speed where horn comes on, buffet

**NOTE:** Do this for speed where horn comes on, buffer speed and stall speed.

REFERENCES

1. Pilot's Operating Handbook and FAA Approved Airplane Flight Manual for the Beechcraft Sundowner 180 C23, Beech Aircraft Corporation, Wichita, Kansas, August 1980.
2. Military Specification, Flying Qualities of Piloted Airplanes, Department of the Air Force, Washington, D.C., MIL-F-8785C, 5 November 1980.
3. Roberts, Sean C., Flying Qualities Flight Testing of Light Aircraft for Test Pilots and Flight Test Engineers, Flight Research, Inc., Mojave, California, September 1981.
4. Military Specifications, Stall/Post-Stall/Spin Flight Test Demonstration Requirements for Airplanes, Department of the Air Force, Washington, D.C., MIL-S-83691A (USAF), 15 April 1972.

|  |                     |                  |                  |
|--|---------------------|------------------|------------------|
| INITIAL FLIGHT TEST REPORT                               |                     | 1. AIRCRAFT TYPE | 2. SERIAL NUMBER |
| 3. CONDITIONS RELATIVE TO TEST                           |                     |                  |                  |
| a. DATE:   | e. CONFIGURATION:   | i. FUEL LOAD:    |                  |
| b. PILOT:  | f. INSTRUMENTATION: | j. SURFACE WIND: |                  |
| c. OBSERVERS:  | g. START UP GR WT:  | k. WEATHER:      |                  |
| d. SORTIE TIME/T.O. TIME:                                | h. START UP C.G.:   | l. GROUND BLOCK: |                  |
| 4. TESTS PERFORMED                                       |                     |                  |                  |
| 5. RESULTS OF TESTS (Continue on reverse side if needed) |                     |                  |                  |
| 6. REMARKS (Continue on reverse side if needed)          |                     |                  |                  |

REF ID: A65424

|  |                     |                  |                  |
|--|---------------------|------------------|------------------|
| INITIAL FLIGHT TEST REPORT                               |                     | 1. AIRCRAFT TYPE | 2. SERIAL NUMBER |
| 3. CONDITIONS RELATIVE TO TEST                           |                     |                  |                  |
| a. DATE:   | c. CONFIGURATION:   | 1. FUEL LOAD:    |                  |
| b. PILOT:  | f. INSTRUMENTATION: | j. SURFACE WIND: |                  |
| c. OBSERVERS:  | g. START UP GR WT:  | k. WEATHER:      |                  |
| d. SORTIE TIME/T.O. TIME:                                | h. START UP C.G.:   | l. GROUND BLOCK: |                  |
| 4. TESTS PERFORMED                                       |                     |                  |                  |
| 5. RESULTS OF TESTS (Continue on reverse side if needed) |                     |                  |                  |
| 6. REMARKS (Continue on reverse side if needed)          |                     |                  |                  |

REPRODUCED ON USAF A FORM 14

Reference: AFITC Form 365 APR '74

## **APPENDIX G**

### **Sample Flying Qualities Data Records, Data Reduction and Plots**

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| Flight 4 - Dynamic Stability; Stalls   | G-17        |

DATE 10 Nov '82  
 INSTRUCTOR Crenshaw

FLIGHT 3 DATA RECORD

Page 1

TAKEOFF DATA: FIELD ELEVATION - 6,172 FEET

ALTIMETER 30.09

WINDS 140/8 knots

PRESS. ALT. 6000 feet

TEMP. 36°F

CD ROLL (P) 1700 seat

FUEL .50 gallons OIL 8 quarts

POST-FLIGHT TACH TIME 571.70

LONGITUDINAL STATIC STABILITY

| Trim Conditions: (RUN 1) |                      |                     | Trim Conditions: (RUN 2) |                     |                     | Trim Conditions: (Right Turn) |                     |                     | Trim Conditions: (Left Turn) |                     |                     |
|--------------------------|----------------------|---------------------|--------------------------|---------------------|---------------------|-------------------------------|---------------------|---------------------|------------------------------|---------------------|---------------------|
| V <sub>i</sub> (KTS)     | V <sub>i</sub> (KTS) | H <sub>i</sub> (FT) | V <sub>i</sub> (KTS)     | H <sub>i</sub> (FT) | T <sub>i</sub> (°C) | V <sub>i</sub> (KTS)          | H <sub>i</sub> (FT) | T <sub>i</sub> (°C) | V <sub>i</sub> (KTS)         | H <sub>i</sub> (FT) | T <sub>i</sub> (°C) |
| 90                       | 90                   |                     | 90                       | 90                  | 1.0                 | 7                             | 0                   | 90                  | 1.0                          | 7 1/2               | 0                   |
| 8000                     | 8000                 |                     | 8000                     | 8000                | 1.2                 | 7 5/16                        | .06                 | 90                  | 1.2                          | 7 9/16              | .18                 |
| +6                       | +6                   |                     | +5                       | +5                  | 1.4                 | 7 5/8                         | .55                 | 90                  | 1.4                          | 7 5/8               | .81                 |
| 570.94                   | 570.94               |                     | 571.15                   | 571.15              | Tach Time           |                               |                     | 90                  | 1.8                          | 8 3/8               | 2.63                |
| 2350                     | 2350                 |                     | 2350                     | 2350                | TP/RPM              |                               |                     | 90                  | 2.0                          | 8 1/2               | Max                 |

Remarks:

\* Values converted to force using calibration curve

MANEUVERING STABILITY

| Trim Conditions: (RUN 1) |                      |                     | Trim Conditions: (RUN 2) |                     |                     | Trim Conditions: (Right Turn) |                     |                     | Trim Conditions: (Left Turn) |                     |                     |
|--------------------------|----------------------|---------------------|--------------------------|---------------------|---------------------|-------------------------------|---------------------|---------------------|------------------------------|---------------------|---------------------|
| V <sub>i</sub> (KTS)     | V <sub>i</sub> (KTS) | H <sub>i</sub> (FT) | V <sub>i</sub> (KTS)     | H <sub>i</sub> (FT) | T <sub>i</sub> (°C) | V <sub>i</sub> (KTS)          | H <sub>i</sub> (FT) | T <sub>i</sub> (°C) | V <sub>i</sub> (KTS)         | H <sub>i</sub> (FT) | T <sub>i</sub> (°C) |
| 90                       | 90                   |                     | 90                       | 90                  | 1.0                 | 7                             | 0                   | 90                  | 1.0                          | 7 1/2               | 0                   |
| 80                       | 80                   |                     | 80                       | 80                  | 1.2                 | 7 5/16                        | .06                 | 90                  | 1.2                          | 7 9/16              | .18                 |
| 75                       | 75                   |                     | 75                       | 75                  | 1.4                 | 7 5/8                         | .55                 | 90                  | 1.4                          | 7 5/8               | .81                 |
| 90                       | 90                   |                     | 90                       | 90                  | Tach Time           |                               |                     | 90                  | 1.8                          | 8 3/8               | 2.63                |
| 95                       | 95                   |                     | 95                       | 95                  | TP/RPM              |                               |                     | 90                  | 2.0                          | 8 1/2               | Max                 |
| 100                      | 100                  |                     | 100                      | 100                 |                     |                               |                     | 90                  | 2.0                          | 8 1/2               | Max                 |
| 105                      | 105                  |                     | 105                      | 105                 |                     |                               |                     | 90                  | 2.0                          | 8 1/2               | Max                 |

\* Values converted to force using calibration curve

\* Values converted to force using calibration curve

LATERAL-DIRECTIONAL STATIC STABILITY

Trim Conditions:

|                       |          |  |  |  |  |  |  |  |  |  |  |  |  |
|-----------------------|----------|--|--|--|--|--|--|--|--|--|--|--|--|
| $V_1$ (KTS)           | 90       |  |  |  |  |  |  |  |  |  |  |  |  |
| $H_1$ (FT)            | 8000     |  |  |  |  |  |  |  |  |  |  |  |  |
| $T_1$ ( $^{\circ}$ C) | -1       |  |  |  |  |  |  |  |  |  |  |  |  |
| $\delta_R$ (IN)       | 16 1/8   |  |  |  |  |  |  |  |  |  |  |  |  |
| Tach Time             | 1.324.87 |  |  |  |  |  |  |  |  |  |  |  |  |
| MAP/RPM               | 2400     |  |  |  |  |  |  |  |  |  |  |  |  |

Remarks: Started at 8500 ft to stay within

+500 ft of 8000 ft.

Mission flown  
2 Dec '82 in  
N6014M.

| $\beta_{aim}$                        | Turn Coordination: $\theta = 45^{\circ}$ |        |                           |         |                                 |         |                           |        |                                  |         |                           |        |
|--------------------------------------|--|--------|---------------------------|---------|---------------------------------|---------|---------------------------|--------|----------------------------------|---------|---------------------------|--------|
|                                      | Right: $F_e$ (1lb <sub>f</sub> )         | 7      | $F_R$ (1lb <sub>f</sub> ) | 7       | Left: $F_e$ (1lb <sub>f</sub> ) | 7       | $F_R$ (1lb <sub>f</sub> ) | 0      | Right: $F_e$ (1lb <sub>f</sub> ) | 7       | $F_R$ (1lb <sub>f</sub> ) | 7      |
| $\beta$ (deg)                        | "  | "      | "                         | "       | "                               | "       | "                         | "      | "                                | "       | "                         | "      |
| $\theta$ (deg)                       | -2                                       | -5     | -10                       | -15     | -20                             | -25     | -30                       | -35    | -40                              | -45     | -50                       | -55    |
| $\delta_R$ (in)                      | 16 3/8                                   | 16 5/8 | 16 7/8                    | 16 17/8 | 16 3/8                          | 16 17/8 | 16 7/8                    | 16 5/8 | 16 3/8                           | 16 17/8 | 16 7/8                    | 16 5/8 |
| * $\delta_a$ (left)                  | -1/8                                     | -1/4   | -3/8                      | -5/8    | -7/8                            | -9/8    | -11/8                     | -13/8  | -15/8                            | -17/8   | -19/8                     | -21/8  |
| * $\delta_a$ (right)                 | 1/8                                      | 1/4    | 3/8                       | 5/8     | 7/8                             | 9/8     | 11/8                      | 13/8   | 15/8                             | 17/8    | 19/8                      | 21/8   |
| $F_R$ (right)<br>(1lb <sub>f</sub> ) | 15.5                                     | 20     | 24                        | 27      |                                 |         |                           |        |                                  |         |                           |        |
| $F_R$ (left)<br>(1lb <sub>f</sub> )  | 0  | 0      | 0                         | 0       |                                 |         |                           |        |                                  |         |                           |        |
| $F_e$ (1lb <sub>f</sub> )            | 0  | 0      | 0                         | 0       | 0                               | 0       | 0                         | 0      | 0                                | 0       | 0                         | 0      |

Left Rudder

Right Rudder

NOTE: Plot data as recorded. No data reduction required.  
\*Indicate 1/8, 1/4, 1/2 deflection, etc.

LONGITUDINAL STATIC STABILITY DATA REDUCTION:

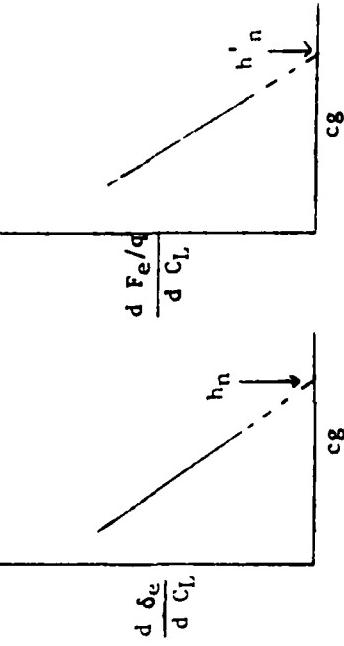
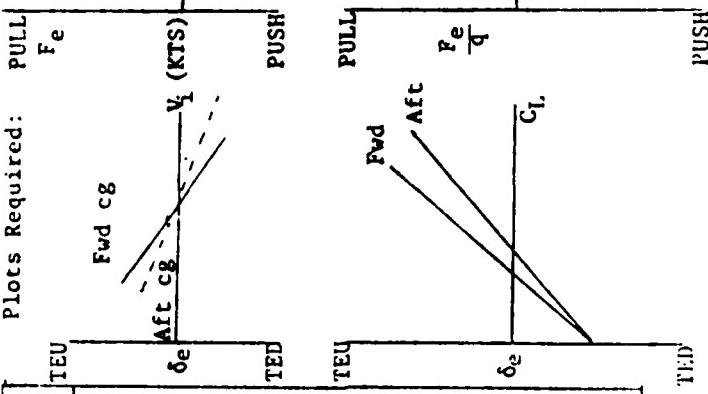
Aircraft, Sundowner 180 C23      Wing Area:  $S = 146 \text{ ft}^2$

| $V_i$ (KTS) | $V_e$ (KTS) | $q$ (PSF) | $C_L$ | $\delta_e$ (inches) | $F_e$ (lb) | $F_e/q$ |
|-------------|-------------|-----------|-------|---------------------|------------|---------|
| 75          | 75          | 19.1      | .88   | 7.44                | 6.6        | .35     |
| 80          | 79          | 21.2      | .80   | 7.25                | 5.5        | .26     |
| 85          | 84          | 24.0      | .70   | 7.19                | 0          | 0       |
| 90          | 89          | 26.9      | .63   | 7.00                | 0          | 0       |
| 95          | 94          | 30.0      | .56   | 6.94                | 0          | 0       |
| 100         | 99          | 33.3      | .51   | 6.81                | 2.5        | .08     |
| 105         | 104         | 36.7      | .46   | 6.75                | 5.0        | .14     |

1.  $V_i$  (KTS) indicated airspeed.
2.  $V_e$  (KTS)  $\approx V_e$  (KTS) equivalent airspeed, p. 5-10 F.M.
3.  $q = \frac{1}{2}\rho_0 V_e^2 = \frac{0.002377}{2} ((2) \times 1.69)^2$

$$4. C_L = \frac{W}{\frac{1}{2}\rho_0 V_e^2 S} = \frac{W}{qS} = \frac{W}{(1)S}$$

5.  $\delta_e$  (inches) Stick displacement in inches
6.  $F_e$  (lb) Elevator force in pounds.
7.  $F_e/q = \frac{(6)}{(4)}$

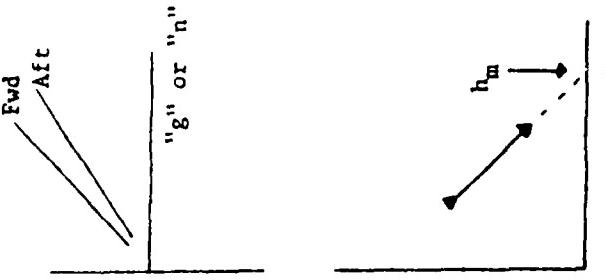
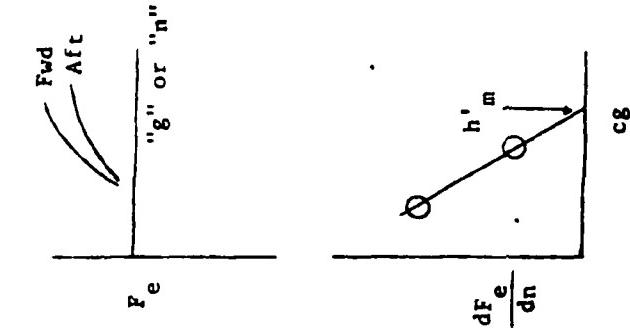


LONGITUDINAL MANEUVERING STABILITY DATA REDUCTION

Aircraft, Sundowner 180 C23

| c.g. | $V_i$ (KTS) | $\delta_e$<br>(inches) | $F_e$ (lb) | "g" |
|------|-------------|------------------------|------------|-----|
| 24.2 | 90          | 7.00                   | 0          | 1.0 |
| 24.2 | 90          | 7.31                   | 2.5        | 1.2 |
| 24.2 | 90          | 7.63                   | 5.75       | 1.4 |
| 24.2 | 90          | 8.38                   | 15.00      | 1.8 |
| 24.2 | 90          | 7.03                   | 0          | 1.0 |
| 24.2 | 90          | 7.28                   | 4.2        | 1.2 |
| 24.2 | 90          | 7.63                   | 6.7        | 1.4 |
| 24.2 | 90          | 8.50                   | 15.00      | 2.0 |

Wing Area:  $S = 146 \text{ ft}^2$



1.  $C_g$  in  $\frac{z}{MAC}$ .  
2.  $V_i$  indicated airspeed.  
3.  $\delta_e$  (in) Stick displacement in inches  
4.  $F_e$  (lb) Elevator forces in lb.  
5. "z" direct reading off gauge.

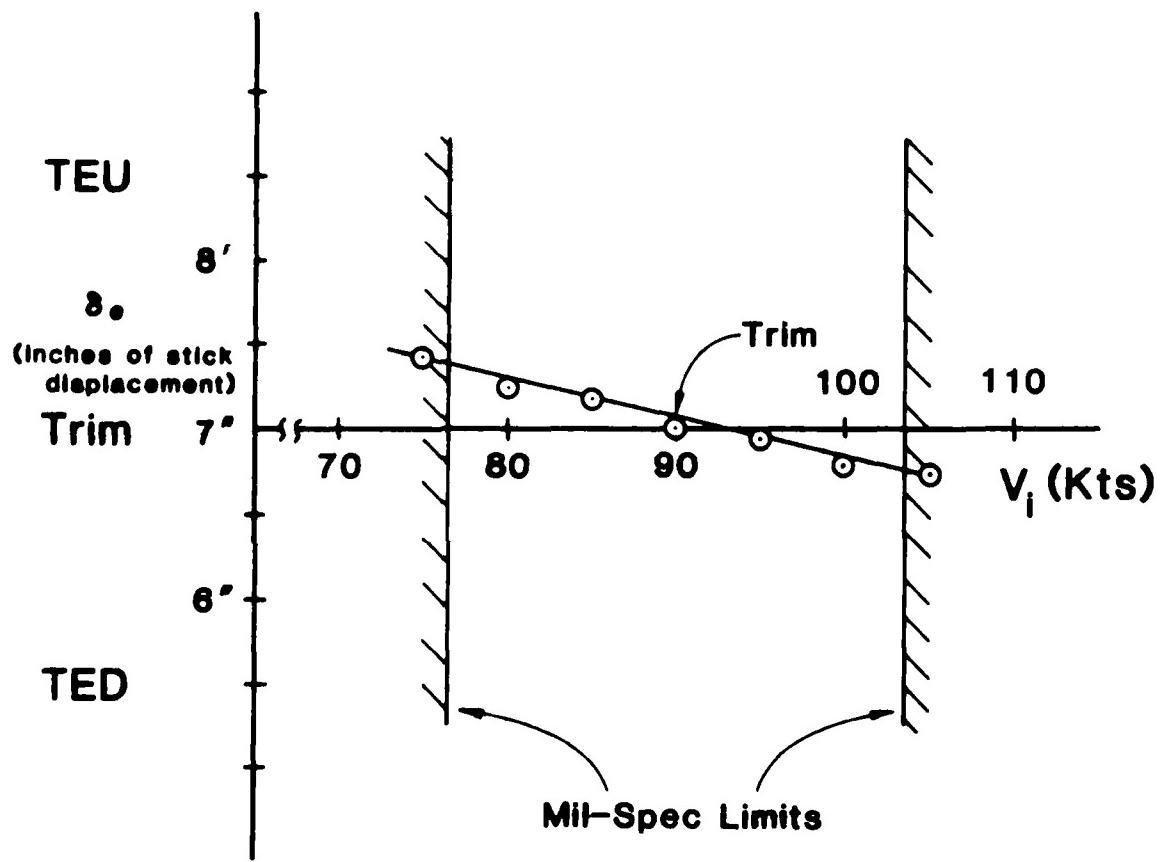
Stick-fixed maneuvering

Stick-free maneuvering

**Beechcraft Sundowner N18325**

10 Nov'82 Alt=8,000 feet 2350 RPM

$V_t = 90$  kts 24% CG

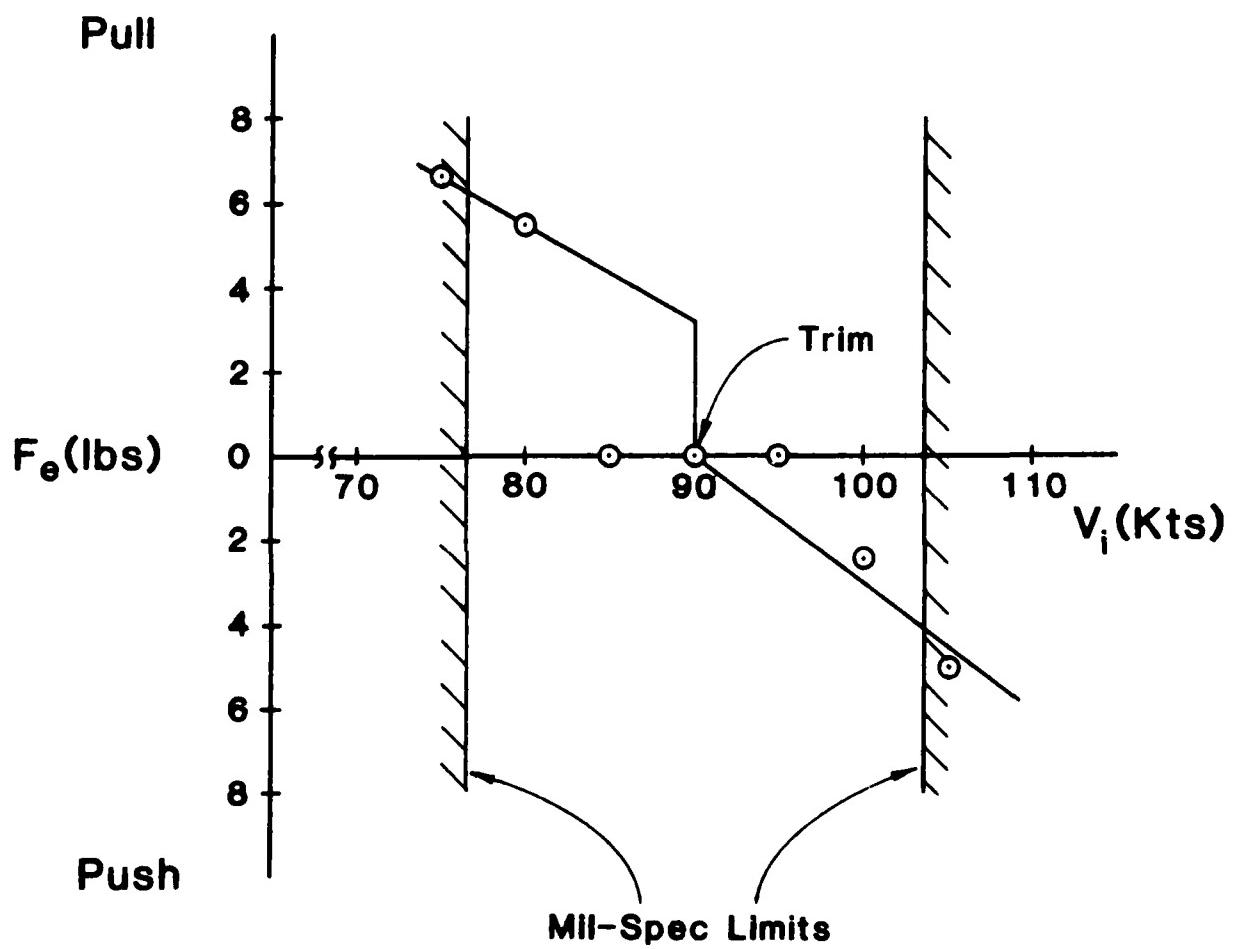


Beechcraft Sundowner N18325

10 Nov'82 Alt=8,000 feet 2350 RPM

$V_t = 90$  kts

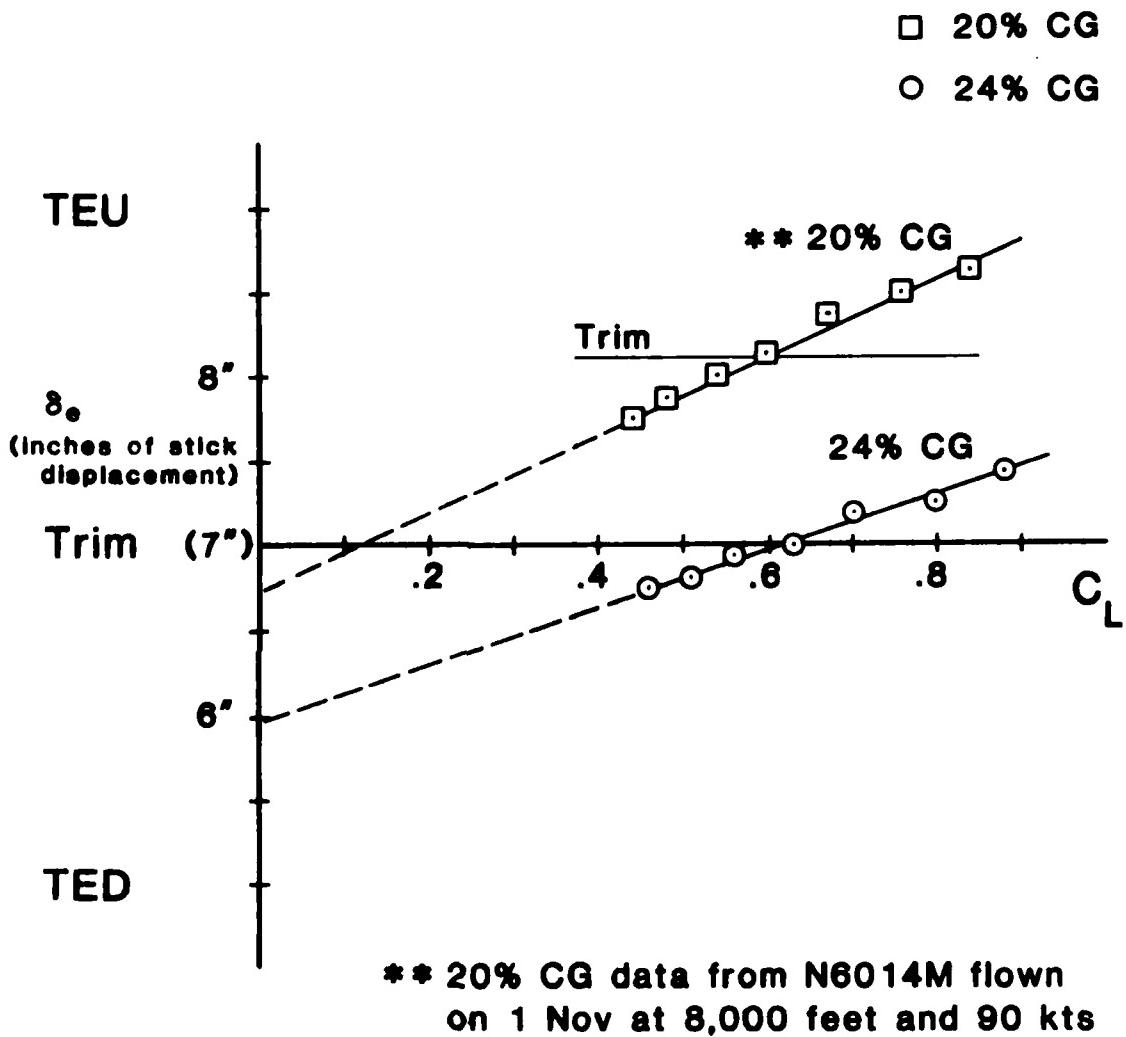
24% CG



Beechcraft Sundowner N18325

10 Nov'82 Alt=8,000 feet 2350 RPM

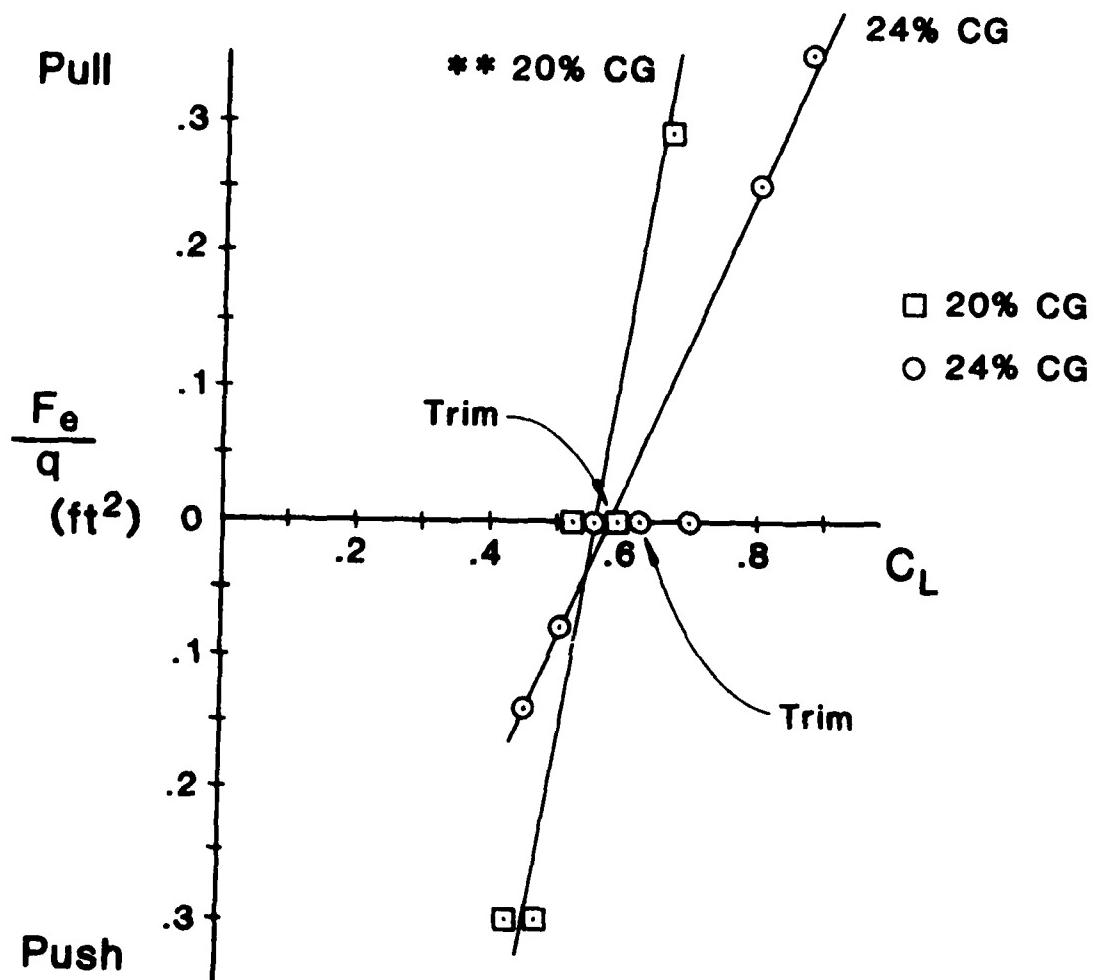
$V_t = 90$  kts 24% CG



Beechcraft Sundowner N18325

10 Nov'82 Alt=8,000 feet 2350 RPM

$V_t = 90$  kts 24% CG



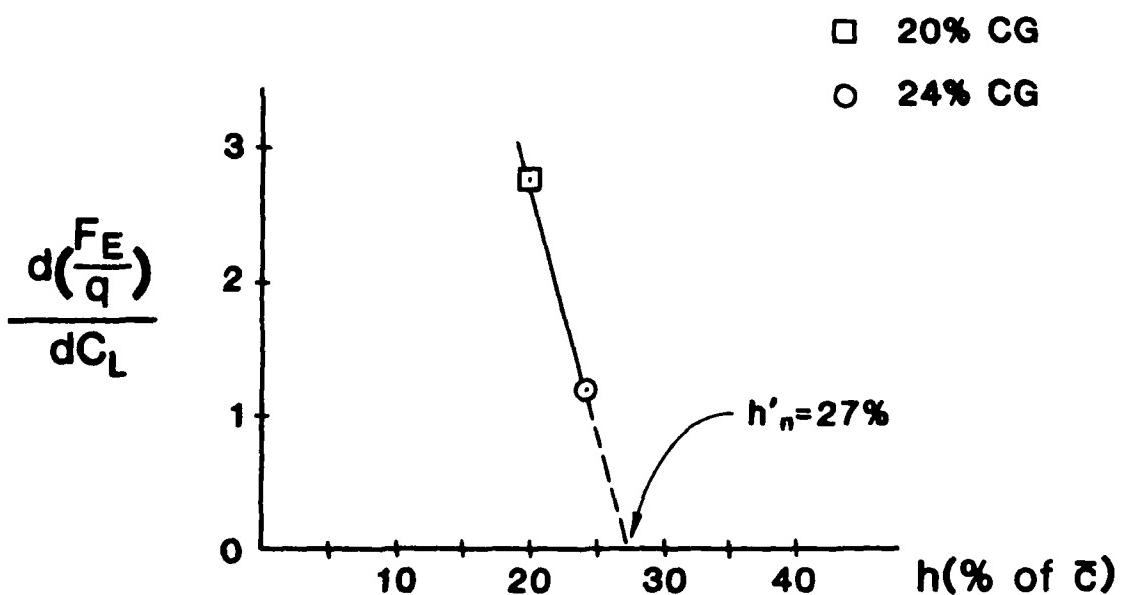
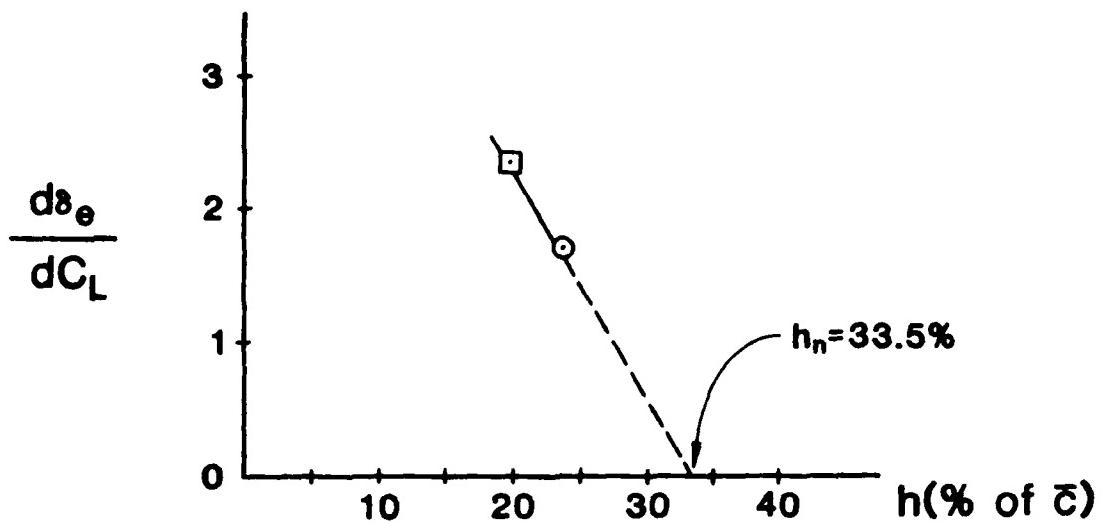
\*\* 20% CG data from N6014M flown  
on 1 Nov at 8,000 feet and 90 kts

Beechcraft Sundowner N18325

10 Nov'82 Alt=8,000 feet 2350 RPM

$V_t = 90$  kts

24% CG

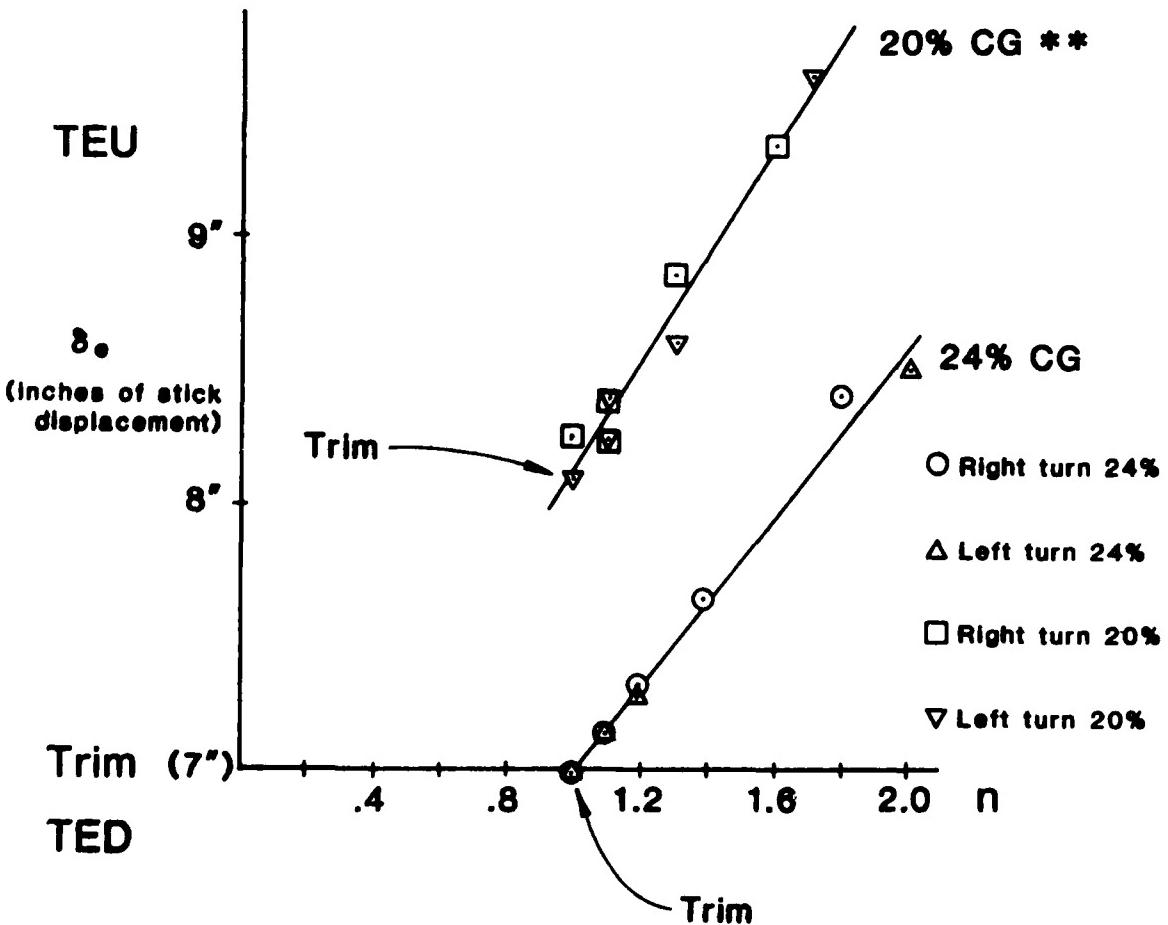


# Beechcraft Sundowner N18325

10 Nov'82 Alt=8,000 feet 2350 RPM

$V_t = 90$  kts

24% CG



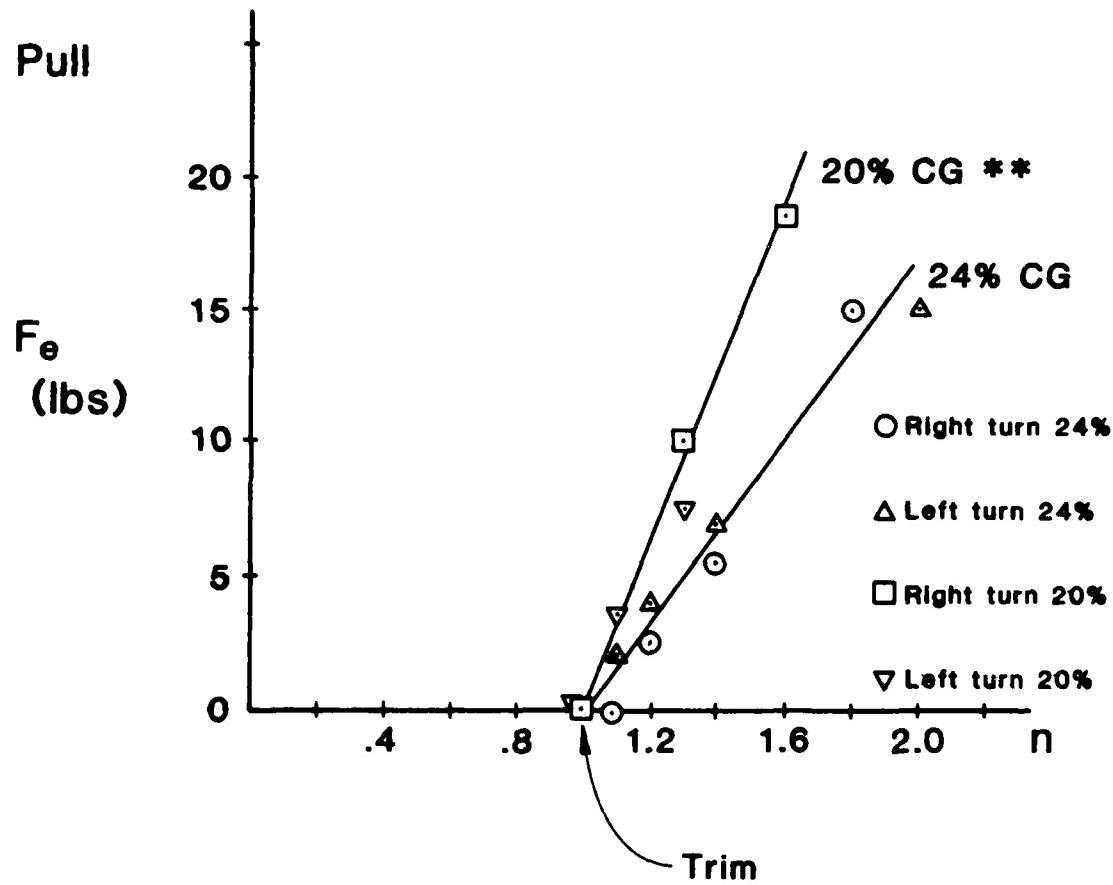
\*\* 20% CG data from N6014M flown  
on 1 Nov at 8,000 feet and 90 kts

Beechcraft Sundowner N18325

10 Nov'82 Alt=8,000 feet 2350 RPM

V<sub>t</sub>=90 kts

24% CG



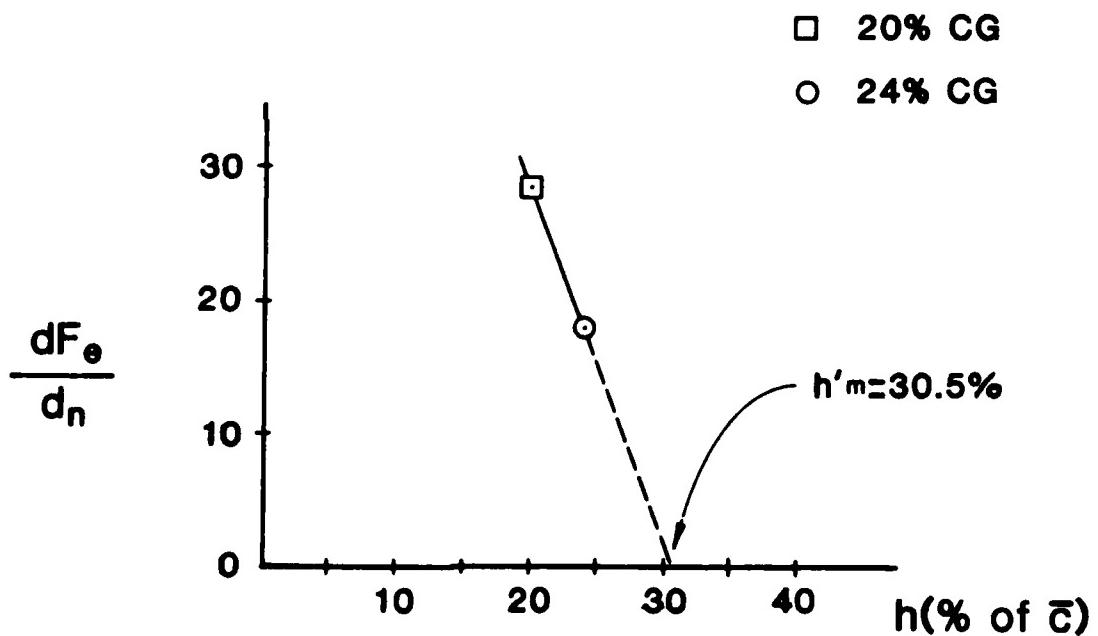
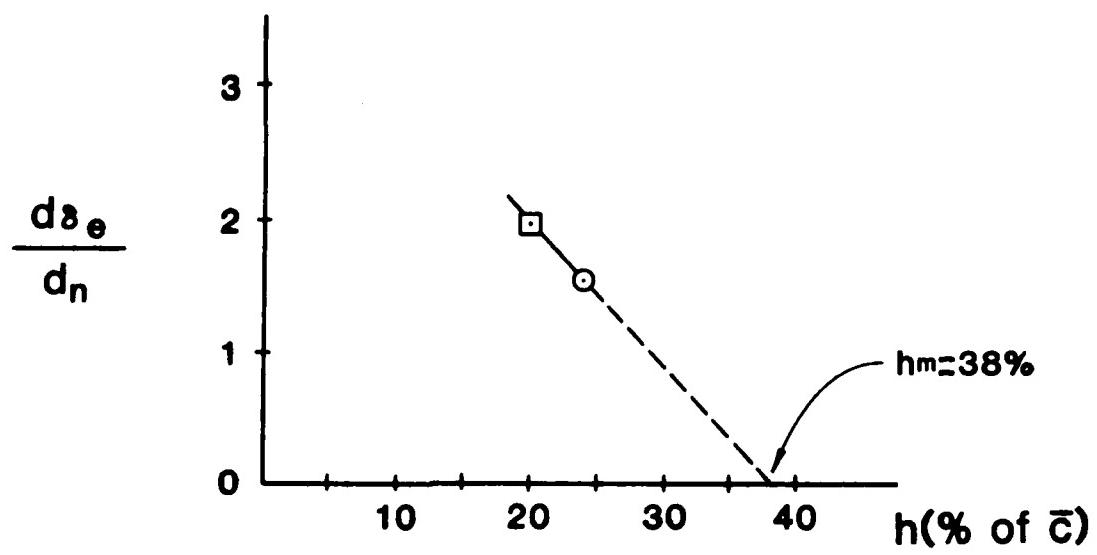
\*\* 20% CG data from N6014M flown  
on 1 Nov at 8,000 feet and 90 kts

**Beechcraft Sundowner N18325**

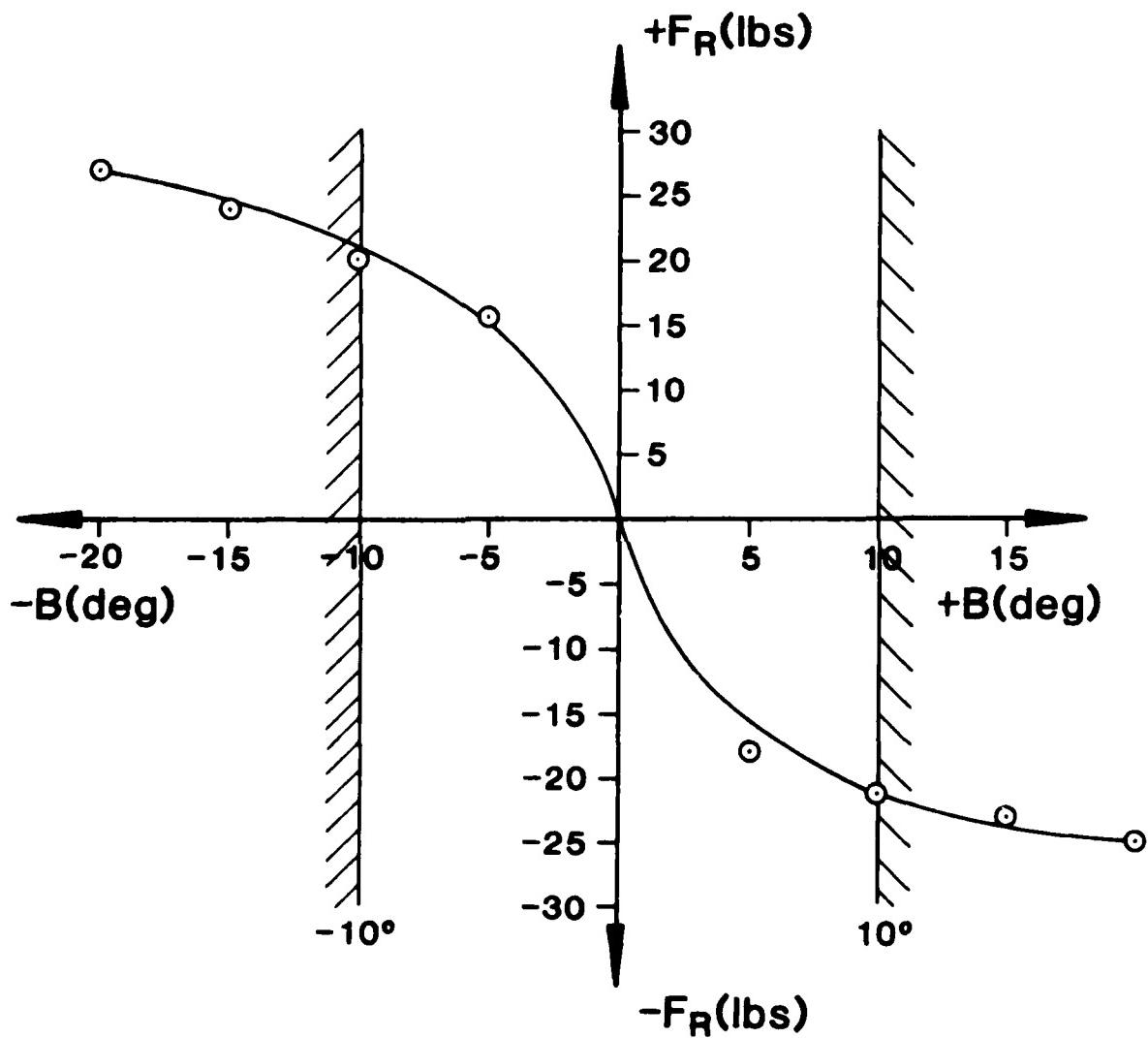
10 Nov'82      Alt=8,000 feet      2350 RPM

$V_t = 90$  kts

24% CG



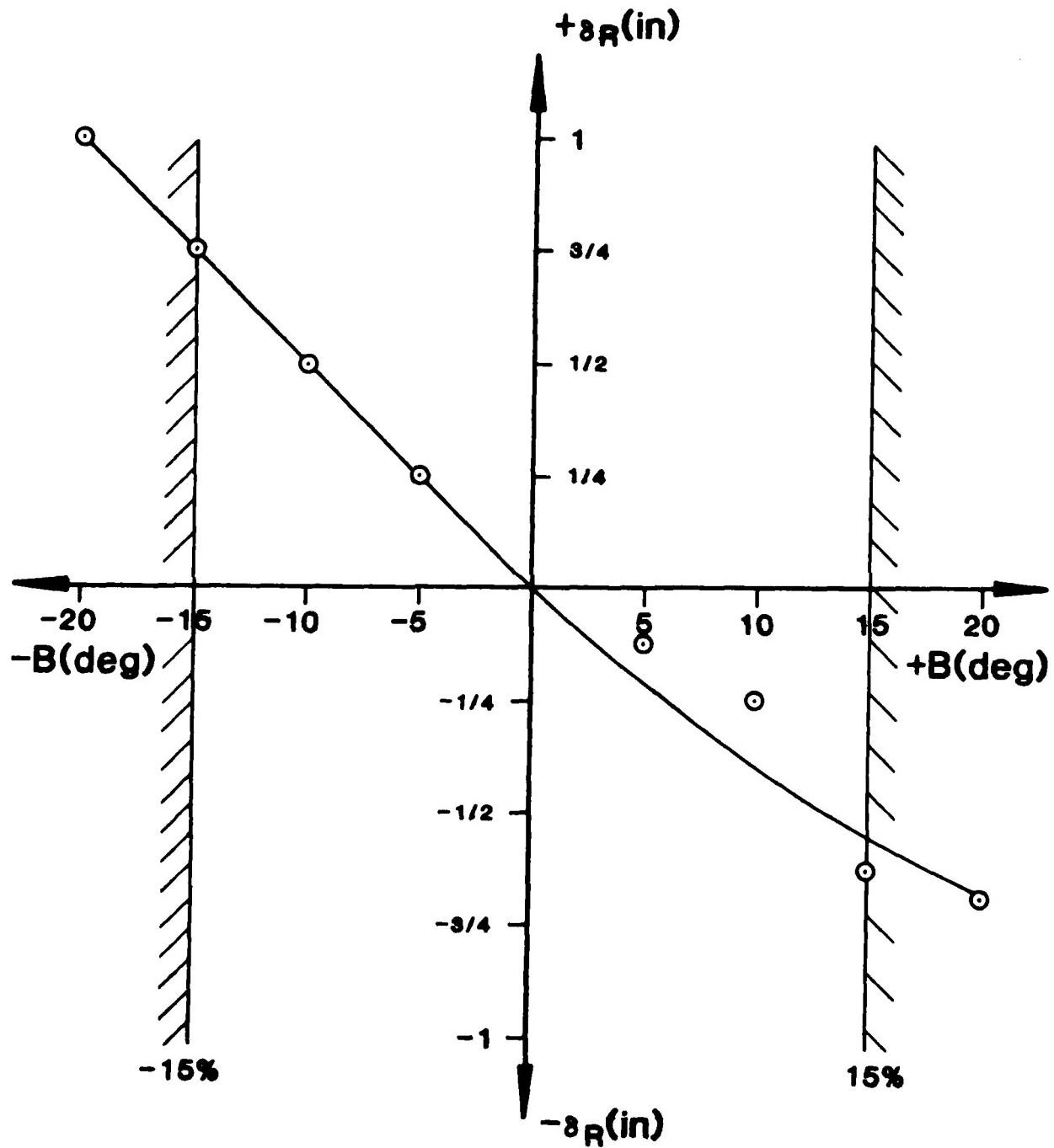
Rudder Force ( $F_R$ ) vs Sideslip Angle ( $B$ )  
Beechcraft Sundowner 180  
Test Alt=8,000 feet     $V_I=90$  kts



**Rudder Deflection ( $\delta_R$ ) vs Sideslip Angle (B)**

**Beechcraft Sundowner 180**

**Test Alt=8,000 feet     $V_i=90$  kts**



FLIGHT 4 DATA RECORD

Page 1

DATE 30 Nov '82

INSTRUCTOR Creasbaw

STUDENTS: OBSERVER - Nordling

RECORDED - Dingley

AIRCRAFT NU. N- 601411

PRE-FLIGHT TACH TIME 1322.36

REMARKS:

TAKEOFF DATA: FIELD ELEVATION - 6,172 FEET  
ALTIMETER 2963  
WINDS 070/6 knots  
PRESS. ALT. 6,350 feet  
TEMP. 32°F  
GD ROLL (P) 1545 feet  
FUEL 57 gallons oil  
POST-FLIGHT TACH TIME 1323.24

LATERAL CONTROL POWER

| STALL TESTING        |           |                     |                                |
|----------------------|-----------|---------------------|--------------------------------|
| Trim Conditions:     |           |                     | V <sub>i</sub> (RTS) <u>76</u> |
| V <sub>i</sub> (KTS) | <u>80</u> | H <sub>i</sub> (FT) | <u>8000</u>                    |
| T <sub>i</sub> (°C)  | <u>+3</u> | Tach Time           | <u>1322.89</u>                 |
| -RPM                 |           |                     | <u>2150</u>                    |

| V <sub>i</sub><br>(KTS) | b <sub>a</sub><br>(L) | b <sub>a</sub><br>(R) | Total<br>Time<br>(sec.) | Time to<br>45° = 60°<br>(sec.) |
|-------------------------|-----------------------|-----------------------|-------------------------|--------------------------------|
| 80                      | 1/2                   | 6.7                   | 4.5                     |                                |
| 80                      | 1/2                   | 5.2                   | 3.3                     |                                |

REMARKS: Rolls done from 45° to 45°  
on bank.

|                          |           |                         |                  |
|--------------------------|-----------|-------------------------|------------------|
| V <sub>i</sub> (horn)    | <u>68</u> | H <sub>i</sub> (horn)   | <u>2100 ft</u>   |
| V <sub>i</sub> (buffet)  | <u>62</u> | H <sub>i</sub> (buffet) | <u>2150 ft</u>   |
| V <sub>i</sub> (stall)   | <u>60</u> | H <sub>i</sub> (stall)  | <u>2200 ft</u>   |
| Alt. Loss in<br>Recovery |           | Bleed Rate              | <u>2 kts/sec</u> |

REMARKS: Recovery complete by  
9025ft. Stall characterized by  
aircraft fall off on right wing

### AIRCRAFT DYNAMICS

Trim Conditions:  $V_i$  (KTS) 80  $H_i$  (FT) 8000  $T_i$  ( $^{\circ}$ C) +3

Tach Time 132300 RPM 2150

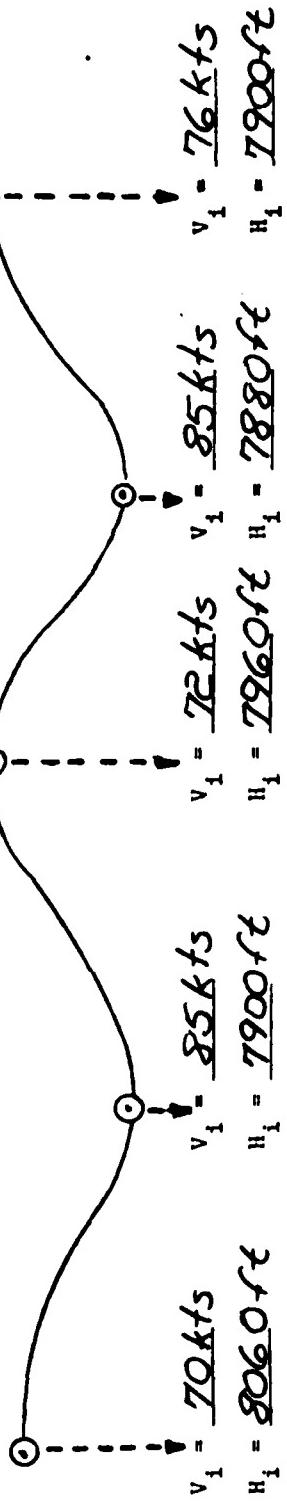
Short Period

Damping >.6 O/S — Time —

Remarks: Deadbeat

Phugoid

$\Delta T = 1.5 \text{ sec's}$   $\Delta T = 2 \text{ sec's}$   $\Delta T = 12 \text{ sec's}$



Remarks: Record  $V_i$  and  $H_i$  each time VVI passes zero.

Dutch Roll

Damping .1 O/S 6 Time 10.3 sec's

Remarks:

$\phi/B$  > 1

Spiral

(Left) 20  $^{\circ}\phi$  to 26  $^{\circ}\phi$  20 seccs  
(Right) 20  $^{\circ}\phi$  to 32  $^{\circ}\phi$  20 seccs

Remarks: Spiral stability affected by lateral center of gravity location.

Lateral Control Power Data Reduction

Aircraft, Sundowner 180 C23

Wing Area = 146 ft<sup>2</sup>

\*①      \*②      \*③      \*④      \*⑤      \*⑥

| $\delta_a$ (R) | $\delta_a$ (L) | t (sec)<br>(L) | t (sec)<br>(R) | $\theta$ (deg)<br>(L) | $\theta$ (deg)<br>(R) |
|----------------|----------------|----------------|----------------|-----------------------|-----------------------|
| 1/2            |                |                | 1.3            |                       | 25                    |
| 1/2            |                |                | 2.3            |                       | 45                    |
| 1/2            |                |                | 3.6            |                       | 65                    |
| 1/2            |                |                | 5.2            |                       | 90                    |
|                |                |                |                |                       |                       |
|                |                | 1.7            |                |                       |                       |
|                | 1/2            |                | 3.3            |                       |                       |
|                | 1/2            |                | 4.8            |                       |                       |
|                | 1/2            |                | 6.7            |                       |                       |

\*Use tape recorder to get these. Recommend in-flight handwritten record as a backup.

1.  $\delta_a$  (R) Right aileron deflection
2.  $\delta_a$  (L) Left aileron deflection
3. Successive time to roll  $\Delta\theta = 90^\circ$  to the left
4. Successive time to roll  $\Delta\theta = 90^\circ$  to the right
5. Successive bank angle  $\theta$  to the left
6. Successive bank angle  $\theta$  to the right
7. Plot  $\theta$  versus t for both left and right turn for each  $\delta_a$  tested

STALL TESTING DATA REDUCTION

| ①             | ②           | ③           | ④           | ⑤      | ⑥              |
|---------------|-------------|-------------|-------------|--------|----------------|
| $H_{pi}$ (ft) | $V_i$ (Kts) | $V_e$ (Kts) | $W_t$ (lbs) | $C_L$  | $V_{iw}$ (Kts) |
| 9100 (horn)   | 68          | 69          | 2459        | 1.0434 | 69             |
| 9150 (buffet) | 62          | 63          | 2459        | 1.2516 | 63             |
| 9200 (stall)  | 60          | 62          | 2459        | 1.8923 | 62             |

1.  $H_{pi}$  (ft) Indicated pressure altitude
2.  $V_i$  (Kts) Indicated airspeed
3.  $V_c$  (Kts)  $\approx V_e$  (Kts) Equivalent airspeed; P. 5-10 F.M.
4.  $W_t$  (lbs) Aircraft test weight: empty weight + fuel + people
5.  $C_L = \frac{2W}{\rho V^2 S} = \frac{2 \times \textcircled{4}}{.002377 (\textcircled{3} \times 1.689)^2}$ , where  $S$  is wing area.
6. Calculate  $C_L$  for each speed
7.  $V_{iw} = \textcircled{3} \sqrt{\frac{W_s}{\textcircled{4}}}$  ( $W_s = 2,450$  lbs)

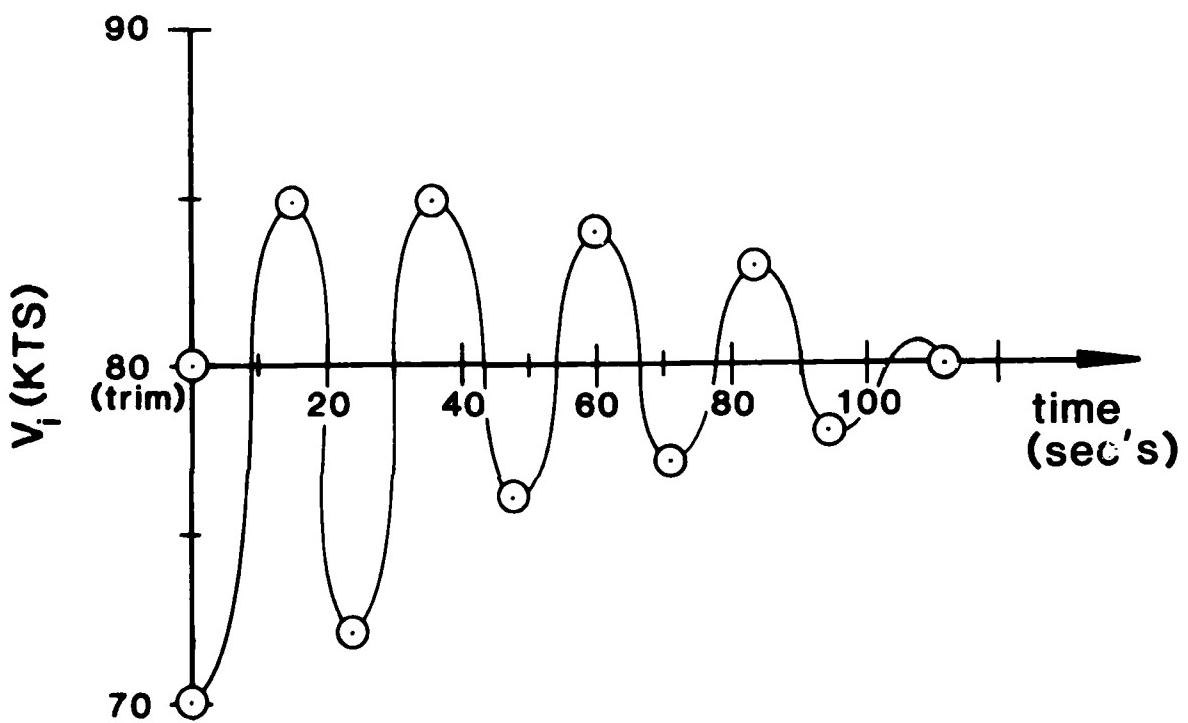
NOTE: Do this for speed where horn comes on, buffet speed and stall speed.

Beechcraft Sundowner N6014M

30 Nov'82     $V_{trim} = 80$  kts     $H=8000$  feet

C.G.=21.7% MAC

Phugoid Dynamic Mode



Data reduced using log decrement:

Period  $T=12$  sec's

Damping  $\zeta=.065$

Actual Frequency  $W_d=.5236$  rad/sec

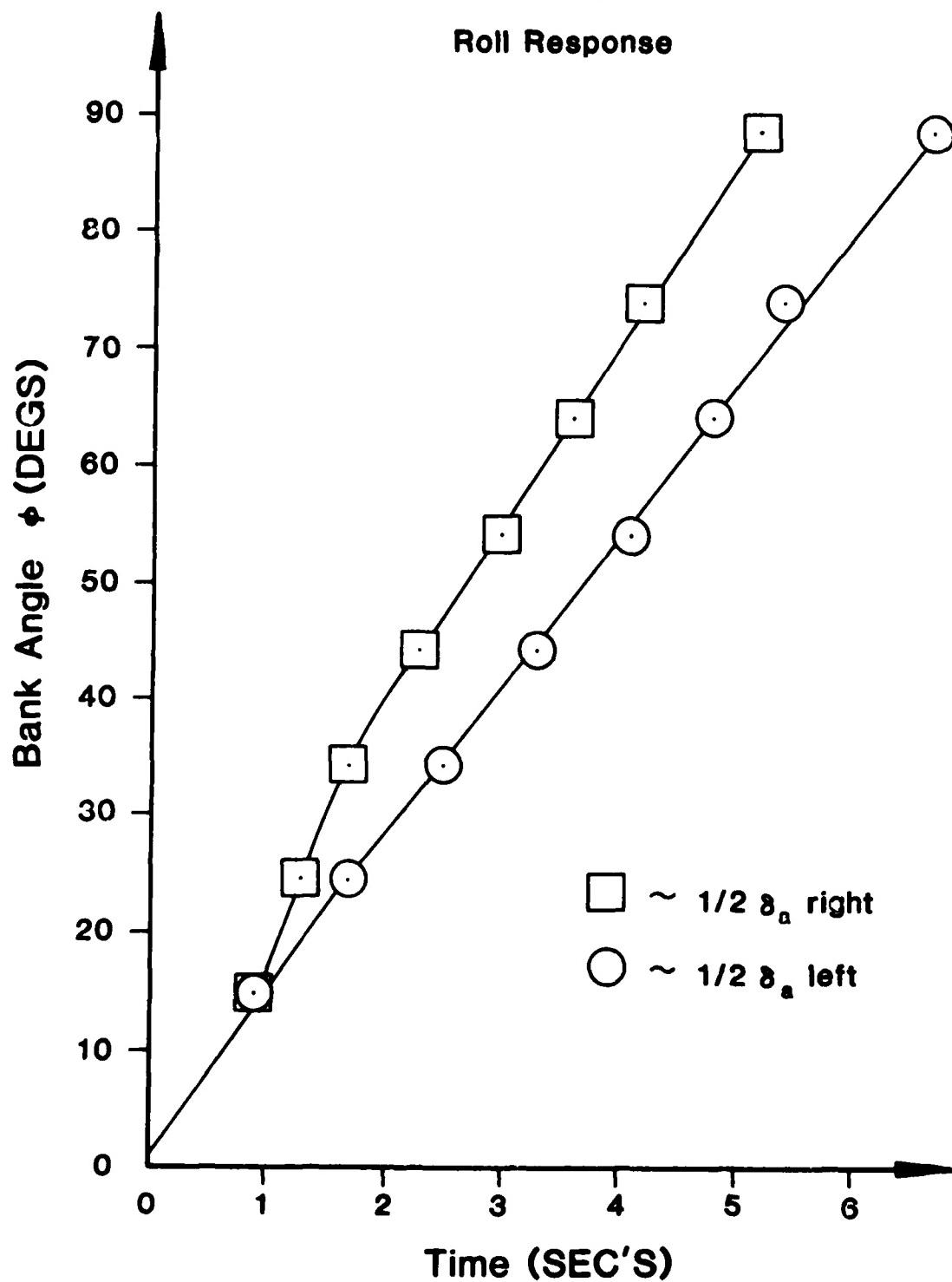
Natural Frequency  $W_n=.5247$  rad/sec

Time to half amplitude  $t_{1/2}=20.23$  sec's

Beechcraft Sundowner N6014M

30 Nov'82       $V_{trim} = 80$  kts      H=8000 feet  
C.G.=21.7%

Roll Response



END  
DATE  
FILMED

9 - 83

DTIC